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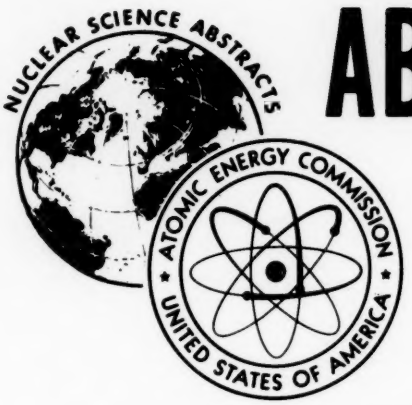

Volume 26 Number 3

Abstracts 4156-6441

February 15, 1972

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TRANSURANIUM ELEMENTS
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separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

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Volume 26, Number 3 February 15, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 4907 and 4967.

4156 (CEA-N-1480) INDUSTRIAL QUALITY CONTROL OF UF_6. Bouzigues, H.; Seyve, C.; Aubeau, R.; Boyer, R.; Toussaint, C.; Fontaine, A.; Baude, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1971. 71p. (In French). Dep. NTIS (U. S. Sales Only).

The methods used in the CEA industrial centers for quality control of UF_6 intended for enrichment are presented: isotopic analysis using mass spectrometry, quantitative analysis of organic materials and other elements in U_3O_8, quantitative analysis of Nb, Ta, rare earths, and Th using emission spectrography, quantitative analysis of Br, Cl, Mo, W, Ru, Sb, V, Cr, and Ti using absorption spectrophotometry, quantitative analysis of ^{232}U using α spectrometry, measurement of fission products and ^{237}U γ activity, measurement of fission product β activity and transuranic α activity. (France)

4157 (LA-DC-12804) ANALYSIS OF NUCLEAR FUELS: A REVIEW. Metz, C. F.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). [1971]. 28p. (SM-149/32; CONF-711107-4). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

The general status of methods of analysis of nuclear fuels is reviewed. It was concluded that there are no serious deficiencies although problems exist which are mostly of a minor nature. The greatest need at this time is for common standard reference materials for methods calibration. This is particularly true for well-characterized materials for the calibration of methods for O/M atom ratio, water, and gases. The international importance of common reference materials is due to increase. It is recommended that a feasibility study be made of the practicality of developing an international program for establishing an adequate set of standard reference materials. (auth)

4158 (LA-DC-12811) PREPARATION AND CHARACTERIZATION OF REFERENCE MATERIAL FOR THE CHEMICAL SPECIFICATION ANALYSIS OF URANIUM-PLUTONIUM MIXED OXIDE FUEL AND SOURCE MATERIALS. Rein, J. E.; Phelps, R. T.; Ashley, W. H.; Waterbury, G. R.; Metz, C. F. (Los Alamos Scientific Lab., N. Mex.). [1971]. 10p. (SM-149/39; CONF-711107-8). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

As a part of the overall analytical chemistry program to ensure the manufacture of high-grade LMFBR/FFTF fuel, all participating laboratories will be supplied with calibration materials for the various chemical specification analyses and will analyze quality control samples during periods of fuel production. The preparation and characterization of the various materials used for the above purposes are described with an emphasis on the powder blends containing metal and nonmetal specification impurities. The blends were prepared by physical mixing of impurity compound powders with powder matrices of uranium-plutonium mixed oxide, uranium oxide, and plutonium oxide that closely match the composition of the fuel pellets and source materials that will be analyzed. The techniques used to obtain homogeneity in these blends, characterized by low concentration levels of the added impurities, are described. Also described are the extensive sampling and chemical analysis characterization to ensure the accuracy and homogeneity of the blends. In addition to these powder blends, batches of mixed oxide pellets were prepared and characterized for uranium and plutonium concentration and isotopic content and for the O/M ratio. These pellets serve as quality control samples for these various analyses. (auth)

4159 (LA-DC-12812) STATISTICALLY DESIGNED PROGRAM FOR SAMPLING AND CHEMICAL ANALYSIS OF REACTOR FUEL MATERIALS. Zeigler, R. K.; Matlack, G. M.; Rein, J. E.; Metz, C. F. (Los Alamos Scientific Lab., N. Mex.). [1971]. 15p. (SM-149/36; CONF-711107-10). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

A sampling program known as the "Variables Sampling Plan," based on standard statistical principles is described. This plan provides the reactor operator with the information that guarantees the nuclear fuel he has purchased from the fuel producer will meet the chemical specifications described in the contract governing production of the fuel. This plan also provides information to the fuel producer about the magnitude and variability of these chemical properties that enables him to balance costs between production quality, chemical analyses expense, and the number of fuel pellets that must be destructively analyzed to determine the quality of the produced lot. An essential part of the plan is a thorough knowledge, based on carefully prepared calibration standards and analytical quality-control materials, of the precision and accuracy of the analytical chemistry methods that are used to measure the chemical properties of the fuel. Thus this program, when properly used, should protect the reactor operator from accepting poor quality fuel and provide the fuel producer with effective quality control resulting in minimum production costs and analytical chemistry costs. (auth)

4160 SORPTION OF IODINE ON HYDRATED MANGANESE DIOXIDE. Mastalka, A.; Benes, J. (Institut fuer Kernforschung, Prague). J. Radioanal. Chem.; 3: No. 3-4, 217-23(Sep 1969). (In German).

The distribution coefficients for iodine were determined in the system "hydrated manganese dioxide-nitric acid" ($K_D \sim 10^4$). Some factors affecting the kinetics and yield of sorption are discussed, and the possibilities of practical application indicated. A mechanism is outlined to explain the sorption of iodine on hydrated manganese dioxide. (auth)

4161 VIth INTERNATIONAL SYMPOSIUM ON MICROTECHNIQUES, HELD IN GRAZ, AUSTRIA, 7-11 SEPTEMBER 1970. Pure Appl. Chem.; 26: No. 1, 1-74(1971). (CONF-700915).

Five papers were presented as plenary lectures at the Symposium of which one was in NSA scope and for which an abstract was written. (UK)

For an abstract of an individual paper see: 4209.

Chemical and Spectral Procedures

Refer also to abstracts 4608, 4630, 4631, 4642, 4643, 5037, 5039, and 5040.

4162 (CEA-R-4215) SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF Ti, Zr, Hf, Nb, Ta, AND V AFTER SE-

LECTIVE SEPARATION WITH B,P,H,A.: APPLICATION TO URANIUM COMPOUNDS. Lamarque, Gerard (Commissariat a l'Energie Atomique, Pierrelatte (France)). Aug 1971. 63p. (In French). Dep. NTIS (U. S. Sales Only).

The extraction of traces of Ti, Zr, Hf, and Nb, and Ta using 0.1, 0.2, and 0.5% N-benzoylphenylhydroxylamine-HCl in benzene was investigated. A further extraction with HCl–HF allowed the concentration of each component to be obtained by spectrophotometric means. The proposed techniques, which are simple and selective, applied to uranium solutions enabled the detection down to 0.15 ppM Ti, 0.08 ppM Zr, 0.12 ppM Hf, 0.05 ppM Nb, and 0.15 ppM Ta with two 5-g uranium test samples. A further 4-g test sample enabled V to be detected down to 0.25 ppM. (auth)

4163 (CONF-711107–1) ANALYSIS OF ADVANCED REACTOR FUELS. Laing, W. R.; Corbin, L. T. (Oak Ridge National Lab., Tenn.). [1971]. 16p. (SM–149/31). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

Preparation of uranium- or plutonium-loaded ion exchange resins for calcination is described, and methods for analyzing the product from the carburization for uranium or plutonium, oxygen, sulfur, and carbon are presented. The role of the oxidizing atmosphere on the conversion of UN to U_3O_8 was studied, and methods for the analysis of uranium nitride, plutonium carbide, uranium carbide, uranium carbonitride, and plutonium carbonitrite are considered. (D.H.M.)

4164 (CONF-711107–2) ANALYSIS OF $(U,Pu)O_2$ FUELS AT OAK RIDGE NATIONAL LABORATORY. Pechin, W. H.; Bradley, R. A.; Lackey, W. J.; Sease, J. D. (Oak Ridge National Lab., Tenn.). [1971]. 20p. Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

In the production of well-characterized $(U,Pu)O_2$ for irradiation testing of fast breeder fuels, an analytical system for process control, quality assurance, and postirradiation examination is needed. The analyses required were oxygen-to-metal ratio, sorbed gas content, heavy metal content, heavy metal distribution, isotopic composition of heavy metal, moisture content, and burnup during irradiation. When the usual drying step was used in the gravimetric determination of the oxygen-to-metal ratio, the ratios were consistently higher. This difference is attributed to oxidation of the sample during drying. To obtain lower background values and better precision in the sorbed gas analysis, the metallic crucible was eliminated and a system devised that does not have to be opened between background determination and sample analysis. A background below 0.005 cm^3/g can be obtained readily. A gamma-ray spectroscopic method was developed to determine the variation of uranium-plutonium ratio from microsphere to microsphere. With microspheres 500 μm in diameter it could detect variations in the ratio Pu/(U + Pu) with a standard deviation equal to ±2% of the true ratio. In the moisture analysis, large quantities of sorbed gas in the fuel contributed very significantly to the results, particularly above 300°C. Water analysis is also very sensitive to moisture introduced during sample loading. A lock to prevent entrance of air during sample loading alleviated this problem. Although a spark-excited mass spectrograph is rapid and convenient for determining many trace impurities, the results from direct analysis of small solid samples were not satisfactory because metallic impurities can form inclusions in the oxide solid solution, causing both high and low results. (auth)

4165 (IAE–1978) APPLICABILITY OF THE D2EHPA–DTPA SYSTEM IN LACTIC ACID FOR GROUP SEPARATION OF TRANS-PLUTONIUM ELEMENTS AND LANTHANIDES. Kosyakov, V. N.; Kazakova, G. M. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The coefficients of distribution of Am, Cm, Cf, and Eu were studied in the system bis-(2-ethylhexyl) phosphate and diethylenetriaminepentaacetic acid in lactic acid as a function of concentration of the complex and of the pH of the aqueous phase. A method was developed for the extraction-chromatographic separation of transplutonium elements from rare earth fission products. This method may be used for either the determination or the purification of transplutonium elements obtained by irradiation of targets. (tr-auth)

4166 (K-Trans–63) IMPROVEMENT IN THE MEASUREMENT OF THE ISOTOPE RATIO OF URANIUM. Komori, Takuji; Tamura, Shuzo; Gunji, Katsubumi; Tamura, Kimiko. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Shitsuryo Bunseki; 18: No. 4, 1270-4(Dec 1970). 8p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 28927.

4167 (LA-DC–12805) DETERMINATION OF NON-METALLIC SPECIFICATION IMPURITIES IN MIXED-OXIDE REACTOR FUELS. Metz, Charles F.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). [1970]. 18p. (SM–149/34; CONF-711107–5). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

Methods are described for measuring micro quantities of carbon, halogens, nitrogen, sulfur, phosphorus, and water in sintered mixed oxide fuels. These methods are capable of measuring these impurities in the parts per million range. An important source of bias in most of these methods is contamination from the laboratory. In addition to clean, orderly laboratories having good ventilation, constant vigilance by the operator is necessary to obtain sustained unbiased values. (auth)

4168 (LA-DC–12810) SEQUENTIAL ION EXCHANGE SEPARATION AND MASS SPECTROMETRIC DETERMINATION OF NEODYMIUM, URANIUM, AND PLUTONIUM IN MIXED OXIDE FUELS FOR BURNUP AND ISOTOPIC DISTRIBUTION MEASUREMENTS. Abernathey, R. M.; Matlack, G. M.; Rein, J. E. (Los Alamos Scientific Lab., N. Mex.). [1970]. 13p. (SM–149/37; CONF-711107–3). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

This method serves two purposes. Used in its entirety, it provides separate fractions of neodymium, uranium, and plutonium for the triple spike, isotope dilution mass spectrometric determination of burnup in mixed oxide fuels. Used in part, it provides separate uranium and plutonium fractions for mass spectrometric measurements of isotopic composition for the specifications analysis of manufactured mixed oxide fuel. In its entirety, the method involves two sequential ion exchange treatments contrasted to five- and six-step operations of most presently used methods. The major operational steps in the entire method are fuming of the sample with perchloric acid to oxidize plutonium to the hexavalent state, transfer of the fumed sample in 12M hydrochloric acid to a highly cross-linked anion exchange resin column, conversion of the effluent containing neodymium, other fission products, and americium to a nitrate medium, and isolation of the neodymium by chromatographic separation on a low cross-linked anion exchange resin column with a nitric acid–methanol elutant. Plutonium is eluted from the first column with a 12M hydrochloric acid–0.1M hydroiodic acid mixture followed by uranium with 0.1M hydrochloric acid. Each of the three fractions is analyzed by thermal ionization mass spectrometry. Alternatively for burnup measurements, with little sacrifice in reliability, plutonium and uranium are eluted together with 0.1M hydrochloric acid and analyzed with one filament loading in the mass spectrometer. When separately eluted, the separation factor is $>1 \times 10^5$ for uranium in the plutonium fraction. This permits the unbiased determination of the ^{238}Pu isotopic content in natural uranium–plutonium mixed oxide fuels in which the initial $^{238}U/^{239}Pu$ ratio is greater than 2000 to 1. (auth)

4169 (NP–19056) ON THE STRUCTURES OF SOME HYDROXO COMPLEXES OF URANYL(VI) IN CRYSTALS AND SOLUTION. Aaberg, Maertha (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 1971. 30p. Dep. NTIS (U. S. Sales Only).

A survey is made of research work that has been done to clarify structurally the hydrolysis reactions of uranyl(VI) in chloride solution. The investigations include structure determinations of the discrete hydroxo complexes of uranyl(VI) that have been found in aqueous solution and in crystals. Comparisons are made with the results reported in the literature from other investigations of the hydrolysis of uranyl(VI) in solution and from other crystal structure determinations of uranium(VI) compounds. (auth) (Sweden)

4170 (SRARI-P–72) SOME METHODS FOR INVESTIGATION OF IRRADIATED FUEL ELEMENTS. Davydov, E. F.; Syuzev, V. N.; Chushkin, Yu. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 32p. (In Russian). INIS.

Basic methods are proposed for investigating irradiated fuel elements involving two stages: before and after sectioning into samples. Examples are given of studies of irradiated fuel elements and of samples from them, and of the course of subsequent development of techniques for their analysis. (tr-auth)

4171 STUDYING THE BEHAVIOR OF ZINC AND CADMIUM BY HIGH-FREQUENCY AND AC POLAROGRAPHY, AND THE DETERMINATION OF THESE ELEMENTS IN TELLURIUM OF HIGH PURITY. Vasil'eva, L. N.; Lukashenkova, N. V.; Krasnobaeva, L. V.; Yustus, Z. L. (State Scientific-Research Inst. of Nonferrous Metals, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1832-5(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1436-9(Dec 1970).

The polarographic determination of 10^{-6}% cadmium and 10^{-5}% zinc in high-purity tellurium was studied. A previously reported study involving a stationary mercury electrode in synthetic solutions for the determination of 2×10^{-9} moles/liter of Cd by ac polarography with accumulation served as the basis for the present work. A 2.4M ammonium chloride solution with p_H 3 to 4 containing 0.3 M hydrazine was chosen as electrolyte for the simultaneous determination of Zn and Cd. (J.G.B.)

4172 COMPARATIVE STUDY OF REAGENTS FOR THE DETERMINATION OF RARE EARTH ELEMENTS IN BINARY MIXTURES. Poluektov, N. S.; Sandu, M. A.; Lau'er, R. S. (Inst. of General and Inorganic Chemistry, Kiev). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1821-3(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1425-8(Dec 1970).

Conditions for the use of various reagents for the photometric determination of rare earth elements of one subgroup in the presence of elements of another are tabulated. It was found that most of the reagents can be used for the determination of rare earth elements of the yttrium subgroup in their binary mixtures with lanthanum or cerium. Extraction-photometric determination of the latter can be carried out in the presence of all the elements of the yttrium subgroup and gadolinium with alizarin S(H_3BO_3, HN_4OH). With pyridylazo-naphthol (PAN), it is possible to analyze binary mixtures of lanthanum (or cerium) not only with elements of the yttrium subgroup and yttrium, but also with neodymium, samarium, and europium. With chromazurol, determination of lanthanum, europium, and all elements of yttrium subgroup in mixture with praseodymium can be carried out. The possibility of determining some elements of the yttrium subgroup in binary mixtures with lanthanum was explored by determining gadolinium and dysprosium using xylenol orange. The possibility of determining europium in mixtures with praseodymium using chromazurol S, and in mixtures with lanthanum using PAN, was also investigated. It was found that determination of elements of the yttrium subgroup in their mixtures with lanthanum is possible in the presence of sodium sulfosalicylate using xylenol orange. Determination of small amounts of europium in lanthanum oxides can be carried out using PAN as the reagent with subsequent extraction with ether. (auth)

4173 DETERMINATION OF MICRO AMOUNTS OF SULFUR IN METALS AND FERROSILICONS. Fedorov, A. A.; Krichevskaya, A. M. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1829-31(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1433-5(Dec 1970).

A previously reported spectrophotometric method developed for the analysis of metallic Cr and Fe was used to determine micro amounts of sulfur in metallic Ca, Mg, Ba, Co, Zr, and ferrosilicons. The method consists of a decomposition of the sample in phosphoric acid, trapping the evolved hydrogen sulfide, and photometric determination. In the analyses of different samples a proportionality was observed between sample size and the amount of sulfur found. This affirms the completeness of the evolution of sulfur as hydrogen sulfide in the dissolution of material in phosphoric acid. To confirm that the sulfate ion is not reduced during the dissolution of the sample in phosphoric acid, duplicate determinations of sulfur were conducted in the presence of certain quantities of standard sulfuric acid containing 12 μg sulfur. The same result was obtained in both cases. The completeness of reduction of sulfate in the presence of Zr or Cr was verified. (J.G.B.)

4174 CONTROL OF PROCESSES FOR THE PREPARATION OF RARE EARTH COMPOUNDS BY MEANS OF SPARK-EXCITED SPECTROGRAPHIC ANALYSIS OF SOLUTIONS. Karpenko, L. I.; Fadeeva, L. A. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1865-7 (Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1462-5(Dec 1970).

An investigation of the effects of sample composition on the intensity of the spectral lines preceded the development of a method for the determination of the individual rare earth elements in solution. It was found that a change in the nature and concentration of the anions (Cl^-, NO_3^-, SO_4^{2-}, BO_3^{3-}) and complex-forming ions (EDTA, CH_3COO^-) does not bring about any appreciable changes in the spectral excitation processes when the rare earth elements enter into the discharge zone of a high-voltage condensed spark in the form of a thin layer on the surface of a porous electrode, or on the magnitude of the relative intensity of the spectral lines of the rare earth elements. It was established that an increase in the total concentration of the lanthanides leads to an increase in the ratio of the intensities of the lines of the neutral and singly ionized atoms of the rare earth elements, but has no effect on the ratio of the line intensities of the rare earth elements being determined and the comparators which are in the same ionization state. This means that common standards can be recommended for the analysis of the various rare earth compounds. It was established that the use of scandium as an internal standard can become a source of systematic experimental error when the samples and standards are of different compositions. Investigations were based on the spark method of analysis of solutions of rare earths. (J.G.B.)

4175 SOME INTERFERENCES IN THE DETERMINATION OF MOLYBDENUM BY ATOMIC ABSORPTION. Kerbyson, J. D.; Ratzkowski, C. (Noranda Research Centre, Pointe Claire, Quebec). Can. Spectrosc.; 15: 43-8(Mar 1970).

Enhancement effects observed during atomic absorption analysis of certain alkaline leach solutions were examined. A variety of salts or oxides that are relatively nonvolatile enhance the absorption of molybdenum in the nitrous oxide–acetylene flame. Depressive effects are less frequent and both effects are reduced in the air–acetylene flame. The molybdenum enhancement can be maximized and the effects of varied sample composition can be minimized by adding a plateau-forming amount of sodium sulfate for saline samples, or of ammonium or aluminum salts. A possible explanation of the data is suggested in terms of a controlled solute vaporization effect primarily. (auth) (Canada)

4176 DETERMINATION OF Br, Ag, AND I IN PHARMACEUTICALS USING X-RAY FLUORESCENCE EXCITED BY GAMMA SOURCES. Svitel, J.; Schiller, P. (Comenius Univ., Bratislava). J. Radioanal. Chem.; 5: No. 2, 343-51(Jul 1970).

The possibility of using γ sources for the x-ray fluorescence analysis of Br, Ag, and I was studied on model samples. The results were applied for the determination of these elements in pharmaceutical products. The optimum channel range was selected and the accuracies obtainable with various types of radiation sources were compared. For routine analysis of pharmaceutical products and other substances of similar composition, the most suitable radiation sources are: ^{125}I for the determination of low concentration of bromine; ^{153}Gd for the determination of silver; and ^{241}Am for that of iodine. (auth)

4177 TRIPHENYLMETHANE DYES AS IODOMETRIC INDICATORS. Rao, N. Venkateswara; Dutt, V. V. S. Eswara (Andhra Univ., Waltair, India). Z. Anal. Chem.; 253: No. 2, 128-9(1971).

It was found that Setoglaucine 0 and Setocyanine Supra can be satisfactorily employed as indicators in the titration of iodine with thiosulfate and arsenic(III). (M.C.G.)

4178 ATOMIC ABSORPTION SPECTROGRAPHIC MEASUREMENT OF RHENIUM IN TUNGSTEN, MOLYBDENUM, AND TANTALUM. Neumann, G. M. (OSRAM-Studiengesellschaft, Munich). Talanta; 18: No. 9, 955-60(Sep 1971). (In German).

Results of the atomic absorption spectroscopic (AAS) behavior of rhenium in the presence of large amounts of tungsten and molybdenum are reported. There are some interferences by the matrix elements, but as these remain constant at higher concentrations of tungsten and molybdenum, AAS can be applied without prior separation procedures for the determination of rhenium in Re–W and Re–Mo alloys in the macro- and semi-micro region. With a sample size of 1 g/50 ml the lower determination limits were 750 and 560 ppM in W and Mo respectively. The sensitivity found for 1% absorption was 5 μg Re/ml. (auth)

4179 DETERMINATION OF ALUMINIUM IN MOLYBDENUM AND TUNGSTEN METALS, IRON, STEEL, AND FERROUS AND NON-FERROUS ALLOYS WITH PYROCATECHOL VIOLET. Donaldson, Elsie M. (Dept. of Energy, Mines and Resources, Ottawa). Talanta; 18: No. 9, 905-15(Sep 1971).

A method for determining 0.001 to 0.10% of aluminum in molybdenum and tungsten metals is described. After sample dissolution, aluminum is separated from the matrix materials by chloroform extraction of its acetylacetone complex, at pH 6.5, from an ammonium acetate–hydrogen peroxide medium, then back-extracted into 12M hydrochloric acid. Following separation of most co-extracted elements, except for beryllium and small amounts of chromium(III) and copper(II), by a combined ammonium pyrrolidinedithiocarbamate–cupferron–chloroform extraction, aluminium is determined spectrophotometrically with Pyrocatechol Violet at 578 nm. Chromium interferes during color development but beryllium, in amounts equivalent to the aluminium concentration, does not cause significant error in the results. Interference from copper(II) is eliminated by reduction with ascorbic acid. The proposed method is also applicable to iron, steel, ferrovanadium, and copper-base alloys after preliminary removal of the matrix elements by a mercury cathode separation. (auth)

4180 RECENT DEVELOPMENTS IN MASS SPECTROSCOPY. Proceedings of the International Conference, Kyoto,

September 8–12, 1969. Ogata, Koreichi; Hayakawa, Teruo (eds.). Baltimore; University Park Press (1970). 1342p. $37.50. (CONF-690926).

Separate abstracts were prepared for 69 of the 190 papers presented. Three of the papers were previously included in NSA as 24: 6358, 8892, and 20714. The remaining 118 papers were out of scope. (W.H.K.)

For abstracts of individual papers see: 4181–4188, 4306, 4316, 4396–4398, 4421, 4422, 4432, 4496, 4497, 4623–4640, 4914, 4915, 5025, 5035–5041, 5109, 5110, 5153, 5154, 5167, 5187–5192, 5915, 5916, 5960, 5961, 6021, 6080–6085, and 6139.

4181 QUANTITATIVE ANALYSIS OF SOLIDS BY SPARK SOURCE MASS SPECTROMETRY. Ahearn, A. J. (National Bureau of Standards, Washington, D. C.). pp 150-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

In spark source mass spectrometry, the ion sample generally misrepresents the solid sample. Consequently, standard reference materials are needed for direct comparison with the unknown or for the determination of correction factors. The precision in measurement of matrix element ions, trace element ions, and their ratio is dependent on the homogeneity of the ion sensitive emulsion used. Methods for testing emulsion uniformity and results on Q2 plates are presented. In some the nonuniformity is less than 5%; in others up to a 60% change in 8 cm was detected. Under optimum conditions, matrix ions are measured with an RSD ≤ 5% but with trace ions this precision is usually poorer. This means that the trace element contents of the recorded ion sample fluctuate. The trace ions in a spark source ion sample from NBS SRM Platinum 681 fluctuate but not independently. Ion microprobe and other tests should indicate whether the observed fluctuations arise in solid sample inhomogeneities or in fluctuations in the production and/or transmission of trace ions in SSMS. (auth)

4182 SPARK SOURCE MASS SPECTROSCOPY FOR TRACE ANALYSIS. Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). pp 158-68 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The criteria used in evaluating trace techniques in general (sensitivity, scope, accuracy and precision, selectivity, and sampling and standard requirements) are discussed and the relative position of spark source mass spectroscopy is examined. Several applications of spark source mass spectroscopy to difficult trace problems are described including determination of bulk concentration of trace elements in high-purity materials and complex biological and geological samples, as well as the probe analysis of iron meteorites. (D.H.M.)

4183 RELATIVE SENSITIVITY COEFFICIENTS FOR NEGATIVE IONS. Makita, T.; Kodera, K.; Kishi, H. (Kyoto Univ.). pp 329-33 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Preliminary results are presented on experimental relative sensitivity coefficients for negative atomic ions. The results may be useful both for the analysis of trace elements in solid samples by means of vacuum spark source mass spectrometry and for the study on correlations between negative ion formation in atoms and electron configurations. (D.H.M.)

4184 MASS SPECTROGRAPHIC ANALYSIS OF NONCONDUCTING SOLIDS. Orzhonikidze, K. G.; Melashvili, V. A.; Sikharulidze, G. G.; Glinkskikh, V. M. (Physical-Technical Inst., Sukhumi, USSR). pp 362-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Two ways of mass spectrographic analysis of nonconducting solids are described. In one of them a vacuum-deposited thin layer of a metal (~0.1μ) is used as conducting electrode. The second way allowed performance of analysis without conducting electrodes. The results of analysis of various insulators of sensitivity up to 10^{-6}% are given, including aluminum oxide and beryllium oxide for zirconium, molybdenum, samarium, etc. (auth)

4185 RECENT IMPROVEMENTS IN PRECISE AND ABSOLUTE ISOTOPE RATIO MEASUREMENTS. Roth, E.; Bir, R.; Hagemann, B. (CEN, Saclay, France). pp 403-19 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Uses of isotope ratio measurements are reviewed and the progress made in isotope ratio measurements is analyzed. It was concluded that although no single breakthrough can be said to have been achieved since the last international conference on mass spectroscopy in 1967, in the field of isotope measurement very substantial progress has been registered, particularly in abundance determinations. A typical consequence of these improvements is that the atomic weights of several elements are about to be modified to take into account better known isotopic compositions. (D.H.M.)

4186 PERFORMANCE OF SIMPLIFIED MOLECULAR BEAM ION SOURCES FOR URANIUM ISOTOPE MASS SPECTROMETERS. Smith, L. A.; Langdon, A. (Union Carbide Corp., Oak Ridge, Tenn.). pp 450-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A mechanically simplified ionization region and gas inlet nozzle structure and methods of immobilizing the UF_6 not ionized in its passage through the ion region were developed. The memory level was lowered, increasing the range of isotopic concentrations measured on one spectrometer, reducing the number of isotopic standards required, and lessening the frequency of memory measurements. Ion source life was extended, and the variance of isotopic determinations was improved. (auth)

4187 DIFFICULTIES IN MEASURING THE ISOTOPIC ABUNDANCES OF CALCIUM WITH A MASS SPECTROMETER. Heumann, K. G.; Lieser, K. H.; Elias, H. (Technische Hochschule, Darmstadt, Ger.). pp 457-60 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A detailed study on the development of a mass spectrometric method for the determination of calcium isotopic ratios is presented. The dependence of the isotopic ratio on the chemical state of the sample, on the temperature of the ionization filament, and on the size of the crystal was considered. By careful standardization of the whole procedure with calcium carbonate, the error of the mass spectrometric determination of the isotopic ratios can be reduced to less than 0.1% per mass unit. (D.H.M.)

4188 BURNUP DETERMINATION OF NUCLEAR FUEL. Inoue, K. (Hitachi Ltd., Kawasaki, Japan); Taniguchi, K.; Murata, T.; Mitsui, H.; Doi, A. pp 461-5 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A general description on the burnup-determining experiments for uranium dioxide fuel specimens is given. Burnup-determining experiments were performed satisfactorily by means of radiochemical, mass spectrometric, and nondestructive methods. The results were 6,100 to 9,400 MWD/T (radiochemical), 7,980 ± 400 MWD/T (mass spectrometric), and 7,500 ± 750 MWD/T (nondestructive). (D.H.M.)

4189 SPECTROPHOTOMETRIC DETERMINATION OF LANTHANUM, THORIUM, AND IRON(III) WITH CHROMOTROPIC ACID AZO DYES OF THE PYRIDINE SERIES. Majumdar, A. K.; Chatterjee, A. B. (Jadavpur Univ., Calcutta). Talanta; 18: No. 9, 968-72(Sep 1971).

Highly sensitive methods for the determination of lanthanum, thorium, and iron(III) were developed with the sodium salts of 2-(pyridyl-2-azo)chromotropic acid, 2-(pyridyl-3-azo)chromotropic acid, and 2-(2-carboxypyridyl-3-azo)chromotropic acid. Optimum concentration ranges are of the order 1 to 20 ppM. The effect of diverse ions (cations and anions) including those of rare-earths are reported. The nature of the complexes was investigated and values for the instability constants are given. (auth) (UK)

4190 PREPARATION OF THIN FILM DEPOSITS FROM BIOLOGICAL, ENVIRONMENTAL, AND OTHER MATTER. Jolly, R. K.; White, H. B. Jr. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 97: No. 1, 103-5(1971).

A technique for preparing uniform thin film deposits (10 to 1000 $\mu g/cm^2$) of practically all materials of biological, environmental and nuclear physics interest is proposed. The technique involves preparing a solution or colloidal suspension of micron size parti-

cles of the substance of interest, generating a nebulized (practically invisible) mist from this liquid and condensing the mist on a rotating substrate. The cost in time and money for several materials is minimal. (auth)

4191 LITHIUM CONTENT DETERMINATION IN LITHIUM FLUORIDE BEFORE AND AFTER VACUUM EVAPORATION. Le Duigou, Y.; Lauer, K. F. (CBNM, Geel, Belgium). Nucl. Instrum. Methods; 97: No. 1, 199-200(1971).

The lithium content of a lithium fluoride has been determined using a gravimetric sulfate method. The standard deviation of the mean value of 11 determinations is ±0.03% (99% confidence limits). No significant difference has been found between the lithium content of evaporated fluoride samples and the lithium content of the starting fluoride material. (auth)

4192 DIRECT EDTA TITRATION OF SCANDIUM, YTTRIUM, AND SOME RARE EARTH METALS WITH IRON-N-BENZOYL-N-PHENYLHYDROXYLAMINE AS INDICATOR. Das, B.; Shome, S. C. (Presidency Coll., Calcutta). Anal. Chim. Acta; 56: No. 3, 483-6(Oct 1971).

The strongly colored iron(III)-N-benzoyl-N-phenylhydroxylamine (BPHA) complex in ethanol solution was studied as an indicator for the titration of Sc, Y, and some rare earth metals. Upper limits for the titration of Sc, Y, and rare earth elements were found to be 3.8 mg, 4.0 mg, and ca 5.2 mg, respectively. A procedure for the simultaneous determination of thorium and rare earth metals (including Sc and Y) by EDTA titration using BPHA indicator solutions is also presented. At pH = 2.0, the EDTA titration is carried out for determining Th. The pH is then raised to 5.0 and the second titration gives the value for the rare earth, yttrium, or scandium present. (D.H.M.)

4193 PHOTOMETRIC TITRATION OF URANIUM WITH CERIUM(IV) OR CHROMIUM(VI). van Rossum, G. J.; den Boef, G.; Poppe, H. (Univ., Amsterdam). Anal. Chim. Acta; 56: No. 3, 481-2(Oct 1971).

Results of a study of the photometric titration of uranium with Ce(IV) or Cr(VI) show that when ca. 10^{-3} M solutions of U(IV) are titrated, the induction of the atmospheric oxidation of U(IV) is not caused by the presence of metal ions only, but is very probably due to the combined presence of metal ions and hydrogen peroxide. The method described makes possible the selective determination of U in the presence of other metals, without exclusion of air from the column and the effluent. When 10-ml aliquots of the effluent containing ca. 1 mg of U were titrated, the standard deviation was 0.5%. When present in 30-fold amounts, Fe, Al, Co, Ni, Mn, and Cr did not interfere. Nitrate, Cu, and Ti can be tolerated in amounts equal to U. (D.H.M.)

4194 DETERMINATION OF THULIUM(III) IN BORATE AND PHOSPHATE GLASSES. Reisfeld, Renata; Eckstein, Y. (Hebrew Univ., Jerusalem). Anal. Chim. Acta; 56: No. 3, 461-5(Oct 1971).

A method for determining Tm in sodium borate and sodium metaphosphate glasses was developed, and since Tm has been shown to transfer energy to Er in these glasses, the fluorescence of Tm in the presence of Er was also studied. Since the fluorescence intensity of Tm(III) shows a linear dependence on the concentration of Tm within the range 0 to 0.75 wt % in borate glasses and 0 to 1.0 wt % in phosphate glasses, these concentration ranges can be used for simple determinations. At higher concentrations, where quenching occurs, Tm can be determined by means of calibration curves. (D.H.M.)

4195 SPECTROCHEMICAL ANALYSIS OF THIN FILMS OF BINARY ALLOYS OF Ni-Ta AND Ni-B. Schoenfeld, I. (Soreq Nuclear Research Center, Yavne, Israel). Anal. Chim. Acta; 56: No. 3, 458-60(Oct 1971).

A spectrochemical method is presented for determining alloying elements in various stages of the production of nickel-base thin-film alloys. The method covers the range 0.4 to 5% for Ta and 0.5 to 3% for B. (D.H.M.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 4397, 4399, 4549, 4550, 4562, 4564, and 6281.

4196 (BARC/I-87) DETERMINATION OF SPECIFIC ACTIVITY AND ISOTOPIC COMPOSITION OF PLUTONIUM. Srinivasan, N.; Ramaniah, M. V.; Jain, H. C.; Mathew, K. A. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 6p. INIS.

The method used for the determination of specific activity and isotopic composition of plutonium is described. The specific activities of the samples were determined by alpha proportional counting and alpha liquid scintillation counting. The isotopic compositions of the samples were determined by the alpha spectrum obtained by using a 400-channel analyzer. The values obtained for different samples of plutonium are presented. (INIS)

4197 (BNL-16182) DEVELOPMENT OF A SYSTEM FOR TRACE ELEMENT ANALYSIS IN THE ENVIRONMENT BY CHARGED PARTICLE X-RAY FLUORESCENCE. Gordon, B. M.; Kraner, H. W. (Brookhaven National Lab., Upton, N. Y.). [1971]. 20p. (CONF-710925-1). Dep. NTIS.

From International meeting on chemical analysis by charged particle bombardment; Namur, Belgium (5 Sep 1971).

The analysis of biological, environmental, consumer products, and lunar samples for trace elements by a charged particle x-ray fluorescence method using accelerated protons and ^{4}He ions is reported. (D.H.M.)

4198 (EUR-4675) RAPID AND SIMPLE METHOD FOR DETERMINATION OF TOTAL ALPHA RADIOACTIVITY IN URINE. Camera, V.; Barassi, G.; Legros, J. J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 14p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 500,-.

A rapid and simple method is described for the total determination of alpha emitters (Pu, Th, Pa, and Np) in urine by means of the extraction, in a beaker, of radionuclides in a solution of trioctylphosphine oxide (TOPO) on a base of Mitene 350/80 (polyethylene). The method can be used for the quantitative determination of natural thorium in urine (by means of colorimetry with Arsenazo III) and for the search for one or more alpha-emitting radionuclides, always in urine, in case of an accident or of suspected internal contamination. (auth)

4199 (LA-DC-12801) NONDESTRUCTIVE ANALYTICAL TECHNIQUES FOR MATERIALS IN THE NUCLEAR FUEL CYCLE. Walton, R. B.; Augustson, R. H.; East, L. V.; (and others) (Los Alamos Scientific Lab., N. Mex.). [1971]. 25p. (CONF-711107-9). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

The applicability and need for nondestructive assay as a complement to analytical chemistry for the analysis of nuclear materials are clearly evident for most segments of the nuclear fuel cycle. The capabilities and physical characteristics of nondestructive assay instrumentation are well-suited for application directly in production or process lines, where measurement needs are greatest. A major role for these methods is in the assay of whole containers of materials which are difficult to sample or otherwise not amenable to chemical analysis. Methods are now available for rapid measurement of every material unit of finished product, and systematic errors for such quality control can be reduced to as little as ~0.1% by using carefully characterized standards. It is predicted that utilization of nondestructive measurements in the management and control of nuclear materials will increase markedly in the near future. (auth)

4200 (ORO-3346-84) NUCLEAR AND X-RAY SPECTROSCOPY WITH RADIOACTIVE SOURCES AND FAST NEUTRON REACTIONS. Seventh Annual Progress Report. Fink, R. W. (Georgia Inst. of Tech., Atlanta. School of Chemistry). 31 Oct 1971. Contract AT(40-1)-3346. 34p. Dep. NTIS.

Research progress is reported on: K-shell investigations; L-shell investigations; M-shell investigations; apparatus and efficiency measurements for x-ray detection; γ spectroscopy on ^{249}Cf, ^{245}Am, and other transuranium sources; multipolarity determination; miscellaneous γ spectroscopy; UNISOR on-line isotope separator program; and orbital electron capture studies with gaseous radioactive sources. (M.C.G.)

4201 RADIOCHEMICAL DETERMINATION OF OXYGEN TRACES IN SELENIUM. Gobrecht, H. (Technical Univ., Berlin); Braetter, P.; Willers, G.; Baum, S. J. Radioanal. Chem.; 5: No. 2, 271-5(Jul 1970).

A sensitive method for determination of oxygen in selenium is described. Oxygen is converted into the gaseous compound sulfur dioxide labeled with ^{35}S. The β radiation of ^{35}S is measured by liquid scintillation counting. The detection limit is 0.02 ppM. The efficiency of vacuum distillation in the purification of selenium, and the influence of air, dry oxygen, and water on the absorption of oxygen by selenium were investigated. (auth)

4202 RADIOMETRIC AND ANALYTICAL APPLICATIONS OF THE NATURAL INSTABILITY OF ^{87}Rb. Zaduban, M. (P. J. Safarik-Univ., Kosice, Czech.). J. Radioanal. Chem.; 5: No. 2, 291-301(Jul 1970). (In German).

Possibilities of the radiometric determination of Rb in liquid

and solid samples using ^{87}Rb are discussed. In spite of the relatively low β energy of ^{87}Rb, it is possible to achieve relatively high total counting efficiency (up to 75%) using gas flow GM counters. This fact makes it possible to use the natural instability of ^{87}Rb also for purposes of calibration. The conditions of radiometric determination mainly of small amounts of Rb are described (minimum measurable amount is 0.07% of Rb). ^{87}Rb can be used for the minimum activity determination by measuring β radiation in the interval of energy of 0.27 MeV. (auth)

4203 DETERMINATION OF ^{226}Ra AND ^{228}Ra IN SOILS AND PLANTS, USING ^{225}Ra AS A YIELD TRACER. Smith, K. A.; Mercer, E. R. (Letcombe Lab., Wantage, Eng.). J. Radioanal. Chem.; 5: No. 2, 303-12(Jul 1970).

Recovery of ^{226}Ra in analysis is determined using ^{225}Ra separated by anion exchange from ^{229}Th and ^{233}U. Radium is coprecipitated with barium, and purified by ion exchange. ^{226}Ra and ^{217}At (decay product of ^{225}Ra) are measured by α spectrometry. ^{228}Ra is determined both by β counting ^{228}Ac and ^{225}Ac separated from ^{228}Ra and ^{225}Ra, and by α counting its daughters after the decay of ^{225}Ra. Sources for α spectrometry are prepared by electrodeposition (molecular plating). (auth)

4204 SOLUTION PHASE CHERENKOV COUNTING OF ^{80g}Br AND ^{80m}Br IN THE PRESENCE OF ^{82}Br. Gennaro, G. P.; Collins, K. E. (State Univ. of New York, Buffalo, Western New York Nuclear Research Center, Buffalo). J. Radioanal. Chem.; 5: No. 2, 387-9(Jul 1970).

^{80g}Br and ^{80m}Br (via its ^{80g}Br daughter) were measured with high efficiency in organic solutions by means of the Cherenkov radiation from the high energy β rays emitted in the ^{80g}Br decay. The efficiency for the contaminating ^{82}Br activity was less than 1%. (auth)

4205 RADIOCHEMICAL DETERMINATION OF THE COMPOSITION OF SOLID COMPLEXES. Cecal, Al.; Schneider, I. A. (Univ., Iasi). Radiochem. Radioanal. Lett.; 8: No. 1, 47-51(25 Sep 1971).

Usually the metal/ligand mole ratio in solid complexes is established by elementary analysis. In several cases, however, such an analysis is difficult to perform. A radiochemical method, using labeled metal ions, is described for determining this ratio. The following complexes were studied: Tl(III)-8-hydroxyquinoline, Tl(III)-5,7-dibromo-8-hydroxyquinoline, Co(II)-8-hydroxyquinoline, and Co(III)-α-nitroso-β-naphthol. (auth)

4206 LOW-LEVEL ^{3}H MEASUREMENT AND TRITIATED LUMINOUS-DIAL WATCHES. Kim, St. M.; Vaughn, L. Jr. (University City Science Center, Philadelphia). Radiochem. Radioanal. Lett.; 8: No. 2, 115-18(14 Oct 1971).

A simple method of measurement for ^{3}H release from a luminous-dial watch was devised. ^{3}H released from watches was measured, and the possibility of sample contamination by tritiated luminous-dial watches has been discussed. (auth)

4207 ADSORPTION CHARACTERISTICS OF RADIONUCLIDES ON ZIRCONIUM HEXACYANOFERRATE(II). Kawamura, Shoichi; Shibata, Sadao; Kurotaki, Katsumi (National Inst. of Radiological Sciences, Chiba, Japan). Anal. Chim. Acta; 56: No. 3, 405-13(Oct 1971).

A procedure is described for a rapid and simple determination of ^{59}Fe, ^{60}Co, ^{65}Zn, ^{137}Cs, and ^{95}Zr, including ^{144}Ce, ^{106}Ru, ^{85}Sr in seawater, combined with a Ge(Li) detector after dissolution of the zirconium hexacyanoferrate(II) (FeZr) column on which the radionuclides are adsorbed. The chemical properties of FeZr, the adsorption rates for radionuclides, the pH-titration curves, the ion-exchange behavior and the distribution coefficients in concentrated salt solution are also discussed. (auth)

4208 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN SEA WATER, SEDIMENTS, AND MARINE ORGANISMS. Wong, Kai M. (Woods Hole Oceanographic Institution, Mass.). Anal. Chim. Acta; 56: No. 3, 355-64(Oct 1971).

A radiochemical procedure is described for the determination of plutonium in large samples of seawater, sediments, and organisms with a sensitivity of 0.004 dpM per 100 l of seawater (for a 50-l sample), 0.02 dpM per kg of sediments (100-g sample) and 0.002 dpM per kg of marine organisms (1-kg sample). An iron(II) hydroxide coprecipitation method is used for the concentration of plutonium in seawater. A nitric–hydrochloric acid leaching method is adapted for the treatment of sediments and ashed organisms. Factors influencing the recovery, contamination, and blank activity are discussed. (auth)

4209 MODERN TRENDS IN RADIOCHEMICAL ANALYTICAL METHODS. Kelley, Myron T. (Oak Ridge National Lab., Tenn.). Pure Appl. Chem.; 26: No. 1, 65-74(1971).

From sixth international symposium on microtechniques; Graz, Austria (7 Sep 1970).

Instrumentation for the analysis of mixtures of radionuclides by purely instrumental techniques has improved greatly in recent years both because of increased resolution of the detectors and increased sophistication of data processing equipment. As a result the role of chemical separation techniques is limited to those cases which the instrumental approach alone cannot solve. However, some outstanding applications for solvent extraction, extraction chromatography, and ion exchange chromatography are being made. Large numbers of radiochemical analyses can be performed both more precisely and more cheaply than in the past. (auth) (UK)

4210 DETERMINATION OF ^{243}Am THROUGH ITS DAUGHTER PRODUCT ^{239}Ne. Lebedev, I. A.; Myasoedov, B. F.; Palie, P. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem.; 5: No. 1, 61-9(May 1970).

The extraction of Np(IV), Zr, Nb, Cs, Ce(III), and Am(III) from nitric acid solutions containing oxalate and phosphate ions by solutions of 1-phenyl-3-methyl-4-benzoyl-5-pyrazolone (PMBP) and tri-n-butyl phosphate (TBP) in benzene was investigated. A solution 0.1M in respect to PMBP and 0.25M in respect to TBP was found to extract 99% of neptunium from aqueous solutions 1M in respect to H_3PO_4 and 0.5M in respect to HNO_3. Under these conditions, the extraction of the other elements does not exceed 0.1%. Based on this finding, a procedure was developed to determine ^{243}Am through its daughter product ^{239}Np in solutions containing large quantities of curium and its fission products. The sensitivity of the procedure is 1×10^{-7} mg of ^{243}Am in the sample. The ^{243}Am content is obtained by calculation from measurements of the γ activity of the extracted ^{239}Np. The purification ratio of ^{239}Np is $\sim 10^{5}$ from Zr, Nb, and Ru, $\sim 10^{8}$ from Ce and Cm, and $>10^{12}$ from Cs. (auth)

4211 DETERMINATION OF TRACES OF BISMUTH BY ISOTOPIC EXCHANGE REACTION IN THE ORGANIC PHASE. Stary, J.; Kratzer, K.; Zeman, A. (Univ., Prague). J. Radioanal. Chem.; 5: No. 1, 71-7(May 1970).

A radioanalytical method was developed based on homogeneous isotopic exchange in the organic phase. The theory of the method is presented and discussed. This method was applied for the simple, selective, and rapid determination of bismuth based on the isotopic exchange between bismuth diethyldithiocarbamate and bismuth iodide complex, labeled with ^{210}Bi. As little as 0.01 μg of the metal can be determined. (auth)

4212 POSSIBILITIES OF THE DETERMINATION OF ^{3}H, ^{14}C, AND ^{131}I INDIVIDUALLY AND IN MIXTURES, BY THE METHOD OF AMPLITUDE ATTENUATION USING LIQUID SCINTILLATORS. Zaduban, M.; Stollarova, V.; Palagyi, S. (P. J. Safarik Univ., Kosice, Czech.). J. Radioanal. Chem.; 5: No. 1, 91-105(May 1970).

Possibilities of the determination by radioactivity measurements of ^{3}H, ^{14}C, and ^{131}I are described for the individual nuclides and their mixtures, with the use of liquid scintillators. The changes in the counting efficiency were determined as a function of the parameters of the measuring equipment, and parameters are suggested which make possible the determination of ^{3}H, ^{14}C, and ^{131}I individually, or in the pairs $^{3}H-^{14}C$, $^{3}H-^{131}I$, $^{14}C-^{131}I$, and finally, in the triplet $^{3}H-^{14}C-^{131}I$. (auth)

Activation Procedures

Refer also to abstracts 4493–4495.

4213 (CEA-CONF-1852) MICROANALYSIS BY NUCLEAR REACTIONS. APPLICATION TO SEMICONDUCTORS. Bontemps, Andre; Monnier, Joel; Bruel, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug 1971. 11p. (In French). (CONF-710932-1). Dep. NTIS (U. S. Sales Only).

From second international symposium on the application of vacuum techniques in semiconductor industry, electronic components and micro-electronics; Versailles, France (13 Sep 1971).

The distribution of the B impurities between the Si and SiO_2 of a B-doped Si substrate was studied during the oxidation of the substrate. The microanalysis was performed using nuclear reactions; a mathematical diffusion model was subsequently developed. The diffusion process was studied for different diameter samples, and as a function of certain fabrication parameters. The gas–oxide–silicon exchanges, and the parameters intervening in the DIFFUSI program were studied; this program deals with all the phenomena occurring in the technology involved in the fabrication of planar transistors. (France)

4214 (COO-912-25) NEUTRON ACTIVATION ANALYSIS OF COINS AND COIN-STREAKS. Gordus, Adon A. (Michigan Univ., Ann Arbor. Dept. of Chemistry). [nd]. 39p. Dep. NTIS.

Two nondestructive methods based on neutron activation analysis for obtaining data on the silver fineness of coins are described. The first method involves irradiation of a coin in a low-intensity beam of neutrons emitted by a radioactive plutonium–beryllium mixture (neutron Howitzer). Only isotopes of silver having a half-life of 24 seconds or 2.4 min are detected. The analysis requires 2½ min. In the second method small samples in the form of metal streaks on etched quartz tubing are irradiated in a nuclear reactor. It is possible to detect not only the long-lived radioactive silver, but also radioactive gold. Copper and occasionally arsenic, antimony, and zinc are detected. (D.H.M.)

4215 (FRNC-TH-99) MICROANALYSIS OF S, Si, AND Zn IN GaSb BY DIRECT OBSERVATION OF (p,p'γ) NUCLEAR REACTIONS. Chemin, Jean-Francois (Bordeaux Univ. (France)). 1971. 66p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A method is described for determining the concentrations of certain impurities in crystalline GaSb: the γ radiation emitted in (p,p'γ) type reactions was measured with a Ge(Li) junction. The energy loss and the energy distribution of the incident protons (energy range 1 to 4 MeV) and the differential cross sections in (p,p'γ) reactions with ^{33}S, ^{28}Si, and $^{64,66,68}Zn$ (energy range 3 to 4 MeV) were determined. The accuracy of the results obtained varied with the impurity considered: an accuracy of ±50% was achieved for S at a concentration of 2.4×10^{19} at/cm^3 with a depth resolution better than 0.1 micron. The Si concentration was determined simultaneously. The method has a greater sensitivity for this element but the depth localization is less precise (0.4 microns for protons with energies between 3100 and 3300 keV). The results are not so good for Zn, the chief obstacle being the effect of Ga. (France)

4216 (IFA-MN-12) DETERMINATION OF THE CONCENTRATION OF HAFNIUM IN THE SALTS OF ZIRCONIUM BY RADIOACTIVATION. Popa, Lucretia I.; Dorcioman, D.; Constantinescu, Stela; Pandelica, D.; Popa-Ghitescu, Andriana (Institutul de Fizica Atomica, Bucharest (Romania)). [nd]. 9p. (In French). Dep. NTIS (U. S. Sales Only).

The determination of Hf in Zr salts by means of activation analysis is described. The sample is converted to the oxide and irradiated in a reactor at a flux of 1.1×10^{13} n/cm^2 for 2 hr. After 10 to 15 days "cooling time" the sample is counted using a Ge(Li) detector. The peaks at 482 keV characteristic of ^{181}Hf are readily measured. Hf may be determined to 10^{-7} in comparison to the Zr present. (K.S.W.)

4217 (PRNC-142) ACTIVATION ANALYSIS AS A METHOD FOR TRACING SUSPENDED SEDIMENTS. Aviles, Braulio Mejia; Pedersen, Knud Borge (Puerto Rico Nuclear Center, [Mayaguez]). [1969]. Contract AT(40-1)-1833. 35p. Dep. NTIS.

Neutron activation analysis was applied to the problem of sedimentation in the Mayaguez Bay. The masking effects of ^{24}Na and ^{38}Cl were eliminated by filtering the samples through 0.45-μ millipore filter paper. The papers were allowed to dry in a closed hood to minimize airborne contamination and dust from entering the samples. The weight of the particulate matter in the filter paper was determined by weighing the papers before and after filtration. The filter papers were placed in one-inch polyethylene vials and irradiated for 3 sec, together with aluminum standards. They were analyzed 30 sec later, using a NaI(Tl) crystal. The samples and standards were counted in alternate order for 40 sec live time, for a period which did not exceed 5 min. Aluminum was found to be present in all the samples in different concentrations. The results demonstrated that aluminum may be used for tracing the sediments contributed by river waters, offering the opportunity of determining their distribution pattern and settling rate. (auth)

4218 CONTRIBUTION TO 14-MeV NEUTRON ACTIVATION ANALYSIS USING HALF-LIVES BETWEEN 0.55 AND 873 MILLISECONDS. Golanski, A. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). J. Radioanal. Chem.; 3: No. 3-4, 161-73(Sep 1969).

A study of the possibility of using half-lives between 0.55 and 873 msec in activation analysis with 14-MeV neutrons is presented. The cyclic counting method is used: irradiation and detection are repeated several times and counts are memorized during all successive cycles until good final statistics are reached. The theoretical aspect of the cyclic counting method and the influence of neutron pulse shape on the activation results are discussed. The sample is activated and its activity measured in the same geometry: the sample and the scintillation detector are placed close to the target of the neutron generator. An electronic gating system is used to avoid photomultiplier gain fluctuations involved in neutron bombardment. Detection limits are measured for the following elements: Be, B, Al, Ca, As, Zr, In, Tl, Pb, and Bi. (auth)

4219 DETERMINATION OF TRACE ELEMENTS IN BIOLOGICAL STANDARD KALE BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). J. Radioanal. Chem.; 3: No. 3-4, 175-85(Sep 1969).

Fifteen elements at trace levels were determined by neutron activation analysis in the biological standard kale distributed by BOWEN. La, Br, As, Se, Sc, Ag, Zn, Co, Cr, Sb, Eu, Fe, and Zr were determined by a nondestructive technique using a high-resolution Ge(Li) detector. Two more elements, Au and Hg, were determined after radiochemical separation. The nondestructive procedure is shown to yield data in generally good agreement with those obtained by destructive techniques. Potential sources of error in the nondestructive technique are discussed. (auth)

4220 NEUTRON ACTIVATION ANALYSIS FOR IRIDIUM, PALLADIUM, AND SILVER IN PLATINUM. Cilindro, L. G.; Martin, D. S. Jr. (Ames Lab., Iowa). J. Radioanal. Chem.; 3: No. 3-4, 195-204(Sep 1969).

A sensitive procedure for the simultaneous determination of trace levels of iridium, palladium, and silver in a platinum stock, by thermal neutron activation analysis utilizing gamma spectrometry, was developed. The radiochemical separation scheme involved an elution of the chloro complexes of iridium and silver, and subsequently palladium, through a strongly-basic anion exchange resin, followed by further chemical separation methods. The ion exchange method served to greatly reduce the hazard from radiations emitted by the bulk of the activities in the matrix. Activities of 13.5-hr ^{109}Pd, 74.2-d ^{192}Ir, and 255-d ^{110m}Ag were monitored by accumulation of pulses from a 3-in diam. NaI(Tl) crystal detector. Further discrimination was attained by resolution of decay curves. The procedure provided analyses for a platinum stock of 0.015 ± 0.0021 ppM Ir; 0.028 ± 0.0043 ppM Pd, and 2.4 ± 0.27 ppM Ag. (auth)

4221 REACTOR NEUTRON ACTIVATION ANALYSIS BY TRIPLE COMPARATOR METHOD. De Corte, F.; Speecke, A.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem.; 3: No. 3-4, 205-15(Sep 1969).

The single comparator method was extended to a triple comparator method, using ^{60}Co, ^{114m}In, and ^{198}Au. In this technique, the k-ratios of the elements to be analyzed, now determined against the three comparators, are corrected for each new ratio of thermal to epithermal reactor neutron flux. These flux ratios are calculated from the absolute activities of the three comparators. The thermal neutron activation cross section and the resonance integral for the reaction $^{113}In(n,\gamma)^{114m}In$ were determined. (auth)

4222 DETERMINATION OF THE SPECIFIC ACTIVITY OF CARRIER-FREE ^{125}I PREPARATIONS BY NEUTRON ACTIVATION ANALYSIS. Heydorn, K. (Isotope Lab., Roskilde, Denmark). J. Radioanal. Chem.; 3: No. 3-4, 225-32(Sep 1969).

Chemical methods are unsuitable for determination of the specific activity of commercial ^{125}I preparations because of the unknown chemical state of the iodine in solutions more than a few weeks old. ^{125}I and ^{127}I were determined in samples from seven different manufacturers by instrumental neutron activation analysis; the specific activities found ranged from about 45% to more than 90% of that of the truly carrier-free product. Correlation of the specific activities with the ^{126}I : ^{125}I ratios indicates contamination of one of the products with stable iodine during the manufacturing process. (auth)

4223 USE OF VERY SHORT-LIVED NUCLIDES IN NONDESTRUCTIVE ACTIVATION ANALYSIS WITH A FAST SHUTTLE RABBIT. I. CORRECTION FOR RAPID VARIATIONS IN THE DEAD-TIME. Wiernik, M.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Radioanal. Chem.; 3: No. 3-4, 245-51 (Sep 1969).

An equation for the dead-time correction of measurements of very short-lived isotopes was derived. As an example, this treatment is applied in the measurement of 7.2-sec ^{197m}Au in the presence of 65-h ^{198}Au. (auth)

4224 NEUTRON ACTIVATION ANALYSIS OF TRACES OF CHLORINE IN POLYPHENYLS: EFFECT OF CHEMICAL REACTIONS UNDER REACTOR IRRADIATION. Malvano, R.; Kwiecinski, S. (SORIN, Vercelli, Italy). J. Radioanal. Chem.; 3: No. 3-4, 257-60(Sep 1969).

Polyphenyl samples, both solid and in organic solutions, were irradiated, and the ^{38}Cl activity was measured by direct γ spectrometry. After a suitable cooling period the samples were reirradiated and the ^{38}Cl activities compared. The chloride fraction of the ^{38}Cl activity produced decreased with irradiation time. The "mineralization" process under irradiation must be attributed almost entirely to Szilard–Chalmers reactions. (M.C.G.)

4225 EFFECT OF SAMPLE BULK DENSITY ON THE DETERMINATION OF NITROGEN BY FAST NEUTRON ACTIVATION ANALYSIS. Andersen, G. H.; Algots, J. M. (General Dynamics Corp., San Diego, Calif.). J. Radioanal. Chem.; 3: No. 3-4, 261-4(Sep 1969).

In order to investigate the effect of bulk density on the determination of nitrogen, a series of nitrogen-containing compounds was irradiated with 14.8-MeV neutrons, counted, and compared to a thiourea standard. Correction for bulk density provided results of considerably improved accuracy. (M.C.G.)

4226 DETERMINATION OF HAFNIUM IN ZIRCONIUM CONCENTRATES BY ACTIVATION OF SAMPLES WITH 14-MeV NEUTRONS. Tustanovskii, V. T.; Orifkhodzhaev, U. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1893-5(Dec 1970). Translated from Zavod. Lab.; 36: No. 12, 1482-3(Dec 1970).

The possibility of determining Hf in Zr concentrates by a radioactivation method using 14-MeV neutrons was investigated. The instrumental γ spectrum obtained as a result of irradiating HfO_2 with Si impurities with 14-MeV neutrons is shown. The spectrum obtained as a result of activation of a mixture of Hf, Zr, and Si is also given. The optimum activation time for the determination of Hf in Zr concentrates was calculated. The effects of small quantities of Al, Fe, and Ti were found to be negligible. Effects of Zr and Si were found using the matrix method. The sensitivity threshold and the relative statistical error were also calculated. When the Hf content in the sample is 0.1%, the relative statistical error $\sigma_{Hf} = 1.3\%$. (J.G.B.)

4227 DETERMINATION OF THE FAST FISSION YIELD OF ^{141}Pr USING NEUTRON ACTIVATION ANALYSIS. Pillay, K. K. S.; Meyer, R. J.; Larsen, R. P. (Argonne National Lab., Ill.). J. Radioanal. Chem.; 3: No. 3-4, 233-43(Sep 1969).

A method is described for the determination of the fission yield of ^{141}Pr. This method was developed to determine the fast fission yield of ^{141}Pr in the Mark III loading (enriched uranium with about 2% zirconium) of the fast fission breeder reactor, EBR-1. The burnup of the fuel sample was determined using the previously reported fission yield of ^{137}Cs. Praseodymium was separated from uranium, plutonium, and other fission products by a combination of precipitation and ion exchange stages. Thereafter, ^{55}Mn was added to serve as an internal flux monitor and praseodymium determined by neutron activation analysis. A precision of ±2% was obtained. (auth)

4228 DETERMINATION OF CHROMIUM ON METAL SURFACES BY PROMPT PROTON SPECTROMETRY. Olivier, C.; Peisach, M. (Southern Universities Nuclear Inst., Faure, South Africa). J. Radioanal. Chem.; 5: No. 2, 391-402(Jul 1970).

Surface concentrations of chromium were determined nondestructively on copper and nickel substrates by prompt proton spectrometry during irradiation with 3.5-MeV deuterons. Ground state protons from ^{52}Cr were used as a measure of the chromium content. The analysis required 5 to 30 min. The relative precision obtained was ±1.8% on copper and ±2.4% on nickel substrates. (auth)

4229 EXPERIMENTAL SENSITIVITES FOR 3-MeV NEUTRON ACTIVATION ANALYSIS. Nargolwalla, S. S.; Niewodniczanski, J.; Suddueth, J. E. (National Bureau of Standard, Washington, D. C.). J. Radioanal. Chem.; 5: No. 2, 403-23(Jul 1970).

The experimental sensitivity for 72 different elements using 3-MeV neutron activation was investigated. Using a 200-kV Cockcroft–Walton neutron generator with a 3-MeV neutron flux of about 1.5×10^8 n · cm^{-2} · sec^{-1}, γ spectra of 51 elements were obtained with a sufficient number of photopeak counts for sensitivity calculations using a photopeak integration method. A useful table summarizing the sensitivity results is given. That 3-MeV neutron activation analysis is practical, is demonstrated by the experimental sensitivities obtained. (auth)

4230 GAMMA-RAY SPECTRA AND SENSITIVITIES FOR 2.8-MeV NEUTRON ACTIVATION ANALYSIS. Weber, G.; Guillaume, M. (Univ., Liege). J. Radioanal. Chem.; 5: No. 2, 425-37(Jul 1970).

The use of 2.8-MeV neutrons produced by the D(d,n)^{3}He reaction should be taken into consideration in some applications of radioactivation analysis. The low number of elements activable by these neutrons makes it possible to minimize the matrix interference and the background below the characteristic photopeaks. The very low dead-time of the spectrometric measurements permits the use of the maximum neutron flux available now and in the future. The sensitivity of determination for the 16 main elements activable with a 400-keV Van de Graaff accelerator at a 2.8-MeV neutron flux of 2×10^6 n · cm^{-2} · sec^{-1} on the sample is defined experimentally. (auth)

4231 ACTIVATION ANALYSIS OF MANGANESE IN GaAs, GaP, AND GaAsP SEMICONDUCTORS. Rausch, H.; Salamon, A. J. Radioanal. Chem.; 3: No. 3-4, 265-9(Sep 1969).

The determination of traces of manganese in the intermetallic semiconductor compounds GaAs, GaP, and GaAsP was studied. Solvent extraction was carried out and the ^{56}Mn activity measured by γ spectrometry. (M.C.G.)

4232 NONDESTRUCTIVE DETERMINATION OF CHLORINE IN ORGANIC COMPOUNDS BY NEUTRON CAPTURE GAMMA-RAY MEASUREMENT USING AN ISOTOPIC NEUTRON SOURCE. Kusaka, Y.; Tsuji, H. (Konan Univ., Kobe, Japan). J. Radioanal. Chem.; 5: No. 2, 359-67(Jul 1970).

Neutron-capture γ activation analysis was investigated using a 300-mCi Am–Be neutron source. Prominent photopeaks available for the analysis were observed in several high-sensitivity elements, e.g., 0.477 MeV for boron, 0.336 MeV for samarium, 0.559 MeV for cadmium, 0.230 MeV for cobalt, 0.370 MeV for mercury, and 0.518 and 0.792 MeV for chlorine. As a practical application of the method, determinations of the chlorine contents of various organic compounds were carried out, and it is shown that Cl contents of 5 to 50 w/v% can be determined in this way with an experimental error of less than 5%. (auth)

4233 MULTI-ELEMENT STANDARD FOR ROUTINE INSTRUMENTAL ACTIVATION ANALYSIS OF TRANCE ELEMENTS IN ROCKS AND TECTITES. Kuncir, J. (Inst. of Mineral Raw Materials, Kutna Hora, Czech.); Benada, J.; Randa, Z.; Vobecky, M. J. Radioanal. Chem.; 5: No. 2, 369-78(Jul 1970).

The use of high-resolution Ge(Li) detectors in nondestructive instrumental neutron activation analysis (INAA) of mineral materials makes possible the simultaneous determination of a number of trace elements. In routine applications of INAA the use of a multi-element standard (MES) has proved to have advantages over a set of standards for each determined element. An MES was prepared containing 8 trace elements mixed in a suitable proportion and giving, after neutron activation, long-lived γ emitters, the γ lines of which regularly occur in the γ spectra of silicate mineral materials. This method was used in the determination of Sc, Cr, Co, Rb, Cs, Eu, Hf, and Th in samples of standard rocks and moldavites. (auth)

4234 FAST AND PRECISE DETERMINATION OF FLUORINE IN GEOLOGICAL SAMPLES BY 14 MeV NEUTRON ACTIVATION ANALYSIS. Weber, G.; Guillaume, M. (Univ., Liege). J. Radioanal. Chem.; 5: No. 2, 379-86(Jul 1970).

A fast and precise method of determining fluorine in geological matrices is proposed. The 0.20-MeV photopeak of ^{19}O, induced by the ^{19}F(n,p)^{19}O reaction, was used for this assay. Neutron flux monitoring was achieved by adding an internal standard monitor (20 mg Ce) to each sample and counting the activity due to the 0.74-MeV photopeak of ^{139m}Ce, produced in the ^{140}Ce(n,2n)^{139m}Ce reaction. This activity was considered to be proportional to the neutron flux during the sample irradiation. This method of fluorine determination was checked on two fluorine geological standards, mica and apatite, containing 1.50 and 2.90% fluorine, respectively. The sensitivity of the method, obviously depending upon the matrix composition, was 1.46 mg for the mica standard. (auth)

4235 SIMULTANEOUS DETERMINATION OF COPPER, MANGANESE, ZINC, AND SODIUM IN PLANT MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Qureshi, I. H.; Cheema, M. N. (Atomic Energy Centre, Lahore, Pakistan). J. Radioanal. Chem.; 5: No. 2, 323-9(Jul 1970).

Neutron activation analysis was used for the simultaneous determination of Cu, Mn, Zn, and Na in plant materials. The heterocyclic dye PAN was applied as a chelating agent to achieve the group chemical separation of Mn, Cu, Ni, and Zn. Various factors that affect the formation and extraction of the PAN-metal chelates were studied and optimized, using suitable aqueous solutions to selectively strip these elements from the organic phase. This procedure was applied to the determination of these elements in "Bowen's Kale" and U. S. NBC Citrus-leaves and Tomato-leaves samples. (auth)

4236 STUDY OF SOME NUCLEAR REACTIONS INDUCED BY FAST REACTOR NEUTRONS. APPLICATION TO RADIOCHEMICAL DETERMINATION, ESPECIALLY OF SILICON. Haerdi, W.; Daniel, R. (Univ., Geneva). J. Radioanal. Chem.; 5: No. 2, 353-8(Jul 1970). (In French).

The fast-neutron flux available in reactor cores was utilized to define experimentally the sensitivity for determination of 12 different elements, based on fast-neutron nuclear reactions. The fluxes available with the AGN-201 P reactor are in the range of 10^9 to 10^{10} n · cm^{-2} · sec^{-1} in the 1 to 4 MeV region. A good sensitivity was obtained for ^{27}Al, ^{52}Cr, ^{56}Fe, ^{28}Si, ^{23}Na [by (n,p) reaction], ^{27}Al, ^{31}P, ^{89}Y [by (n,α) reaction] and ^{197}Au, ^{183}W, ^{89}Y [by

(n,n′) reaction]; the elements Cl, Ca, Pb failed to give reactions. A nondestructive method for the determination of silicon based on the reaction $^{28}Si(n,p)^{28}Al$ is proposed. The limit of determination is about 0.6 mg for a neutron flux of 10^9 n · cm^{-2} · sec^{-1}. As an example, Si in dimethylpolysilane was determined. (auth)

4237 DETERMINATION OF NICKEL, GOLD, AND SILVER IN GALLIUM ARSENIDE BY RADIOACTIVATION ANALYSIS BASED ON THE QUANTITATIVE ISOTOPE DILUTION PRINCIPLE. Kudo, K.; Hishinuma, N. (Electrical Communication Lab., Tokai, Japan). J. Radioanal. Chem.; 5: No. 2, 331-41(Jul 1970).

A method of radioactivation analysis was developed for determination of Ni, Au, and Ag impurities in gallium arsenide. The separation and substoichiometric extraction of these elements were studied and analytical procedures are suggested for their determination. All components are separated by suitable procedures and determined by substoichiometric methods. Ni is extracted as diethyldithiocarbamate into toluene, Au as a complex of rhodamine-B in chloroform, and Ag as dithizonate in carbon tetrachloride. The contents of Ni, Au, and Ag in a gallium arsenide crystal with a carrier concentration of $1.8 \cdot 10^{16}/cm^3$ were 0.05 to 0.08, 0.006 to 0.008, and 0.002 to 0.005 ppM, respectively. (auth)

4238 PURITY CONTROL OF PALLADIUM USED FOR THE PRODUCTION OF RADIOISOTOPES. II. DETERMINATION OF Ru, Co, Fe, Zn, Cd, AND Hg BY NEUTRON ACTIVATION ANALYSIS. Abdel-Rassoul, A. A.; Aly, H. F.; Madbouly, R. (Atomic Energy Establishment, Cairo). J. Radioanal. Chem.; 5: No. 2, 193-200(Jul 1970).

A high-purity grade palladium matrix used for production of isotopes was analyzed for Ru, Co, Fe, Zn, Cd, and Hg by neutron activation. The chemical procedure is based on addition of respective carriers followed by the simultaneous separation of different elemental impurities by anion exchange chromatography. The method is free from chemical interference. Self-shielding of the matrix material was considered and proved to be within the acceptable experimental error. Secondary nuclear reactions are discussed and found to be negligible under the experimental conditions used. (auth)

4239 DETERMINATION OF RARE EARTH ELEMENTS IN ROCK SAMPLES BY NEUTRON ACTIVATION ANALYSIS. USE OF Ge(Li) DETECTOR IN CONJUNCTION WITH LIGHT-HEAVY LANTHANIDES SEPARATION BY CATION EXCHANGE. Higuchi, H. (Rikkyo Univ., Yokosuka, Japan); Tomura, K.; Hamaguchi, H. J. Radioanal. Chem.; 5: No. 2, 207-22(Jul 1970).

A Ge(Li) detector combined with cation exchange separation was used for determination of 12 rare earth elements (La, Ce, Nd, Sm, Eu, Gd, Tb, Ho, Er, Tm, Yb, and Lu) in rock samples by neutron activation analysis. After purification by the conventional hydroxide–fluoride precipitation, the rare earth elements are separated into two fractions, light (La–Tb) and heavy (Ho–Lu), by EDTA cation exchange, and the γ activities of the two fractions are measured by a Ge(Li) detector. The heavy rare earths, such as Ho, Er, and Tm, can be easily γ-counted without serious interference from the intense Compton background and photopeaks due to the light rare earths such as ^{140}La, ^{153}Sm, ^{152}Eu, and ^{160}Tb. The chemical yields (60%) for the individual rare earths are determined by a reactivation technique. The results obtained for the U. S. Geological Survey standard rocks G-1 and W-1 are compared with the previously reported data. (auth)

4240 SYSTEM FOR THE NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN SAMPLES OF BIOLOGICAL AND ENVIRONMENTAL INTEREST. Edgington, D. N.; Lucas, H. F. Jr. (Argonne National Lab., Ill.). J. Radioanal. Chem.; 5: No. 2, 233-50(Jul 1970).

A neutron activation, ion exchange group separation, and iterative least squares γ spectroscopy method was evaluated. This technique is suitable for multiple trace element analysis in a wide range of biological and environmental materials, since the major contaminants, ^{24}Na, ^{32}P, and ^{42}K, are removed by an anion exchange resin and do not interfere with the analysis of the majority of the trace elements present. The iterative least squares method was tested with a mixture of standards. The reproducibility and accuracy varied from 3 to 26%. The larger uncertainties resulted from (1) the limited statistical accuracy associated with a low counting rate, and (2) bias introduced by the contaminants in the library of standard spectra even though radiochemical purity exceeded 99.8%. The rigorous least squares method can accurately compensate for instrumental drifts so that the sensitivity approaches the limit imposed by the statistical accuracy of the data and of the standard spectra. Minor components of the complex γ spectrum were resolved and proved to be present at levels as low as 0.8% of the integral counting rate. (auth)

4241 STUDIES OF ERYTHROCYTE KINETICS USING STABLE CHROMIUM AND NEUTRON ACTIVATION ANALYSIS. Pillay, K. K. S. (Western New York Nuclear Research Center, Inc., Buffalo); Hagle, R. E.; Glomski, C. A. J. Radioanal. Chem.; 5: No. 2, 265-9(Jul 1970).

The survival of erythrocytes is measured using ^{50}Cr labeling followed by neutron activation analysis. The measured half-life of ^{50}Cr-tagged autologous erythrocytes in the rhesus monkey (17.9 ± 2.7 d) compares favorably with the value of 17.1 ± 1.4 d measured using the standard method of radioactive ^{51}Cr labeling. With the use of stable chromium as a tagging agent, erythrocyte kinetics can be monitored without the problems associated with the use of radioactive isotopes. The method presented is highly reproducible and eliminates the necessity of any chemical separation of chromium. The results of both ^{50}Cr- and ^{51}Cr-labeled erythrocyte survival studies are presented. (auth)

4242 DETERMINATION OF 32 ELEMENTS IN ROCKS BY NEUTRON ACTIVATION ANALYSIS AND HIGH RESOLUTION GAMMA-RAY SPECTROSCOPY. Filby, R. H.; Haller, W. A.; Shah, K. R. (Washington State Univ., Pullman). J. Radioanal. Chem.; 5: No. 2, 277-89(Jul 1970).

Neutron activation analysis and Ge(Li) spectroscopy was used to determine 32 elements in seven U.S.G.S. standard rocks of a wide range of composition. Short half-life nuclides (10 sec to 10 min) were used to measure Sc, Hf, Dy, Mg, Al, Ca, Ti, V (and Na) in an automated rabbit Ge(Li) detector system. The elements K, Cu, Zn, Ga, Sr, Ba, La, Eu, Sm (and Mn) were determined by dissolution of the irradiated sample followed by removal of ^{24}Na on hydrated antimony pentoxide (HAP). Long-lived nuclides were used to measure Sc, Cr, Fe, Co, Zr, Rb, Sb, Cs, Ba, Ce, Eu, Yb, Tb, Lu, Hf, Ta, and Th after decay of ^{24}Na. The method involves little radiochemistry and the separation is selective for ^{24}Na under the experimental conditions used. Elemental concentrations determined agree well with previously published data. (auth)

4243 CESIUM DETERMINATIONS IN POTASSIUM ORE AND SALTS BY INSTRUMENTAL ACTIVATION ANALYSIS METHODS. Smakhtin, L. A.; Merkulov, A. V. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1896-8(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1484-5(Dec 1970).

Several instrumental variants of activation analysis were used to evaluate the effectiveness of the ion-exchange concentration technique for Cs. Analysis was based on the isotope ^{134}Cs ($T_{\frac{1}{2}}$ = 2.07 years), which has a fairly complex γ spectrum in which the two most intense cascade γ lines (E_{γ_1} = 0.789 MeV and E_{γ_2} = 0.605 MeV) stand out. Ore and potassium salt samples were irradiated simultaneously with cesium standards at a flux f = 10^{13} neutrons/cm^2 × sec. Cesium content in the potassium salt was determined from the γ spectra taken with a conventional single-channel scintillation γ spectrometer. Dominating ^{46}Sc activity prevented successful use of this instrument with ore samples. A fast-slow coincidence spectrometer and a semiconductor spectrometer were used for ore, salt, and standard specimens. Results of the measurements are tabulated. Relative errors and the time required in each variant of the measurements are also indicated. The most accurate results for analysis of the potassium salt were obtained with the single-crystal spectrometer. (J.G.B.)

4244 INVESTIGATION BY NEUTRON ACTIVATION OF THE Mg/Fe RATIO AFTER THE REACTION $MgO + Fe_2O_3 \rightarrow MgFe_2O_4$. Vilaithong, T.; Crumpton, D.; Francois, P. E.; Grimes, N. W. (Univ. of Aston, Birmingham, Eng.). J. Inorg. Nucl. Chem.; 33: No. 9, 3165-6(Sep 1971).

The preparation of the technologically important spinel $MgFe_2O_4$ has been the subject of several investigations. According to Paladino (1960) who investigated phase equilibria in the ternary system $FeO-MgO-Fe_2O_3$, Mg^{2+} will replace Fe^{2+} in Fe_3O_4 beyond $MgFe_2O_4$ up to a composition $(MgO)_{0.092} \cdot MgFe_2O_4$, but the stoichiometric composition $MgFe_2O_4$ does not exist as a single spinel phase. Entirely different conclusions were reached by Reijnen (1965) using coprecipitated oxalates as starting material in his method of preparation. The conclusions were based on various assumptions including that the Mg/Fe ratio remained constant in a system containing a slight excess of Fe_2O_3. This assumption was investigated. Results are consistent with those of Paladino. The equilibrium value for x (as defined in the formula $(MgO)_x \cdot MgFe_2O_4$) given by Paladino is somewhat higher than the average magnesium excess found but this excess is also independent of sintering temperature at least up to 1400°C with the experimental uncertainty. The present results do not support Reijnen's claim for the existence of stoichiometric $MgFe_2O_4$ spinel, although his recommendations concerning preparation were followed. (UK)

4245 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF HAFNIUM IN ZIRCONIUM CONCENTRATES AND

ORES. Abbosov, O.; Abrams, I. A.; Pelekis, L. L.; Starchik, L. P. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 20-3(1971). (In Russian).

A neutron activation method for determination of hafnium in zirconium concentrates and ores using thermal neutrons obtained by means of the Linac bremsstrahlung and a beryllium target is described. The sensitivity limit at the activation and the measuring time equal to 1 min is 3×10^{-6}%. The time required for the analysis of the sample does not exceed 5 min. (auth)

4246 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF Au, Ga, AND Sb IN EMITTERS ALLOY SAMPLES. Riekstinya, D. V.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 24-6(1971). (In Russian).

An instrumental neutron activation method for the determination of Au, Ga, and Sb in emitter alloy samples was developed. The Ge – Li semiconductor detector is used. The sensitivity of the method is 1×10^{-10} g for Au, 3×10^{-9} g for Ga and 2×10^{-9} g for Sb. (auth)

4247 INSTRUMENTAL NEUTRON ACTIVATION METHOD FOR DETERMINING P AND Al IN THE ENAMEL OF TEETH. Riekstinya, D. V.; Kizane, G. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 27-30(1971). (In Russian).

An instrumental neutron activation method for determining P and Al in the enamel of human teeth using ^{28}Al was developed. The sensitivity of the method is 1.6×10^{-2} g/g for P and 3×10^{-5} g/g for Al. (auth)

4248 DETERMINATION OF TRACE ELEMENTS IN POLLEN AND SPOROPOLLENIN USING NEUTRON ACTIVATION ANALYSIS. Fawcett, P.; Green, D.; Shaw, G. (Univ. of Bradford, Eng.). Radiochem. Radioanal. Lett.; 8: No. 1, 37-40(25 Sep 1971).

Neutron activation analysis was used to analyze trace elements in pollen and their derived sporopollenins. (auth)

4249 DETERMINATION OF SODIUM IN NEWT EGG CELL NUCLEI BY ACTIVATION ANALYSIS. Whitley, J. E. (Scottish Research Reactor Centre, East Kilbridge, Scotland); Muir, C. Radiochem. Radioanal. Lett.; 8: No. 1, 53-7(25 Sep 1971).

It was possible to determine sodium at the nanogram level in single biological nuclei typically 0.2 mm in diameter. The results differ significantly from those of atomic absorption analysis, where up to 50 nuclei were required to obtain sufficient material for analysis. (auth)

4250 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF LUNAR SAMPLES BY MEANS OF SHORT ACTIVATION. Frana, J. (Inst. of Nuclear Research, Rez, Czech); Vobecky, M.; Randa, Z.; Benada, J.; Kuncir, J. Radiochem. Radioanal. Lett.; 8: No. 2, 97-105(14 Oct 1971).

Instrumental neutron activation analysis employing products of short irradiation was applied to the analysis of lunar soil samples. (auth)

4251 DETERMINATION OF OXYGEN BY THE SPECTROMETRY OF PROMPT GAMMA-RAYS FROM TRITON-INDUCED REACTIONS. Peisach, M. (CEN de Saclay, Gif-sur-Yvette, France). Radiochem. Radioanal. Lett.; 8: No. 2, 119-27(14 Oct 1971).

The prompt gamma rays from triton-induced reactions on oxygen were used for analysis. The method had a relative precision of 2 to 3.5% for surface oxygen concentrations from 50 to 3 $\mu g/cm^2$. The sensitivity with 1900-keV tritons was 0.13 $\mu g/cm^2$ on surfaces of steel or copper but 0.45 $\mu g/cm^2$ on aluminum where interfering gamma rays were emitted. (auth)

4252 SIMULTANEOUS DETERMINATION OF CARBON AND OXYGEN IN ELECTROPLATED GOLD BY ^{3}He ACTIVATION. Kim, C. K.; Vasile, M. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Anal. Chim. Acta; 56: No. 3, 339-45(Oct 1971).

The carbon and oxygen contents in several types of hard electroplated gold and one type of soft gold plate were determined by ^{3}He activation analysis. The results for carbon are in the same range as those obtained from combustion analyses on similar samples. The carbon-to-oxygen ratio was found to vary from 2.5 to about 4 for hard gold plates. The maximum bulk level of carbon and oxygen in a soft gold electroplate was found to be about 10^{-2} atom-%. The technique requires no chemical separations and can easily detect impurities at the ppM level. (auth)

4253 DETERMINATION OF THE URANIUM CONTENT IN SEA WATER BY A FISSION TRACK METHOD WITH CONDENSED AQUEOUS SOLUTION. Hashimoto, Tetsuo (Kyoto Univ.). Anal. Chim. Acta; 56: No. 3, 347-54(Oct 1971).

The uranium content in seawater was determined by counting the fission tracks on muscovite immersed in a condensed aqueous solution during the reactor neutron irradiation. For the condensation from seawater, uranium was coprecipitated with aluminum phosphate. After the precipitate was dissolved in a small amount of dilute nitric acid, an aliquot of this solution in a quartz ampoule was taken up by a piece of muscovite and irradiated with reactor neutrons (KUR). After etching of the muscovite with hydrofluoric acid solution, a microphotograph was taken. The fission fragment tracks on the muscovite surface were counted and the seawater samples were compared with standard uranium solutions. The uranium content in seawater could be determined easily as $3.40 \pm 0.12\ \mu g\ l^{-1}$ without any further chemical purification. (auth)

4254 DETERMINATION OF THALLIUM BY PHOTON ACTIVATION ANALYSIS. Masters, L. W.; Lutz, G. J. (National Bureau of Standards, Washington, D. C.). Anal. Chim. Acta; 56: No. 3, 365-70(Oct 1971).

The determination of trace amounts of thallium by the thermal neutron reaction ^{203}Tl(n,γ)^{204}Tl is complicated because ^{204}Tl is a pure β-emitter, requiring a lengthy and rigorous separation. In addition the half-life of ^{204}Tl is too long to permit decay measurements. A photon activation analysis method was developed for this determination. Bremsstrahlung from a beam of 35-MeV electrons induces the photonuclear reaction ^{203}Tl(γ,n)^{202}Tl. The detection limit is of the nanogram order. There are no interfering photonuclear reactions from lead. (auth)

4255 DETERMINATION OF NITROGEN CONTENT OF GRAINS BY MEANS OF FAST NEUTRON ACTIVATION ANALYSIS. Brune, Dag; Arroyo, Alfredo (Instituto de Asuntos Nucleares, Bogota). Anal. Chim. Acta; 56: No. 3, 473-6 (Oct 1971).

In order to optimize the irradiation conditions in the determination of nitrogen in grain by fast neutron activation analysis, several samples were irradiated simultaneously in a position close to the target. Copper threads were used as flux monitors since the threshold energy for the reaction ^{63}Cu(n,2n)^{62}Cu is about the same as that for the reaction ^{14}N(n,2n)^{13}N. Data are tabulated for the ratio of the ^{13}N activity in the grain to the corresponding ^{62}Cu monitor activity for the geometrical arrangement applied. The mean values of the ratios obtained for the two series studied, containing 1.77 and 5.32% nitrogen, were 1.28 and 3.91, respectively. Considering the relationship between the ratios and the corresponding nitrogen contents, namely 3.91 : 1.28 = 3.05 and 5.32 : 1.77 = 3.00, good agreement is observed for the results obtained by the fast neutron activation technique compared to those obtained by the Kjeldahl method. (D.H.M.)

4256 NEUTRON ACTIVATION ANALYSIS OF PALLADIUM, PLATINUM, AND RHODIUM IN LEAD FOAM. Park, K. S.; Gijbels, R. Hoste, J. (Ghent Univ.). J. Radioanal. Chem.; 5: No. 1, 31-42(May 1970).

The determination of palladium, platinum, and rhodium in industrial concentrates such as lead foam and raw lead by neutron activation analysis is described. The noble elements are separated from the matrix by spontaneous deposition on amalgamated copper powder prior to activation. After the determination of palladium and platinum, rhodium is coprecipitated on iron hydroxide, and the precipitate irradiated for the determination of rhodium. The results are compared with those obtained by fire assay. (auth)

4257 INTERFERENCE BY SECOND ORDER REACTIONS IN ACTIVATION ANALYSIS. Maenhaut, W.; Op De Beeck, J. P. (Ghent Univ.). J. Radioanal. Chem.; 5: No. 1, 115-21(May 1970).

Equations to calculate the second-order reaction interferences in activation analysis were derived. A simple approximation as well as the exact solution were investigated. A new algorithm is proposed for fast and accurate calculations, without the need of a computer with high precision arithmetic. The method can be used for all higher order reaction chains. (auth)

4258 DETERMINATION OF LITHIUM AND ITS ISOTOPIC COMPOSITION BY ACTIVATION ANALYSIS AND MEASUREMENT OF ^{8}Li AND ^{17}N. Wiernik, M.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Radioanal. Chem.; 5: No. 1, 123-31(May 1970).

The nondestructive determination of lithium was performed by using a Cherenkov counter for the detection of the 13-MeV (max) β particles from the 0.84-sec ^{8}Li produced by the reaction ^{7}Li(n,γ)^{8}Li. Under optimal conditions for a favorable signal-to-noise ratio, a count rate of about 35 cps/μg lithium at the beginning of the measurement was obtained, with a background of 4.5 cps and a working range of 3 to 400 μg lithium. The interference

of other elements was studied. Several lithium-containing minerals and a sample of Dead Sea water were analyzed. The isotopic composition of lithium in aqueous solutions was determined by the simultaneous measurement of the neutrons produced by the reactions $^{6}Li(n,\alpha)t$ and $^{18}O(t,\alpha)^{17}N$, and the β particles emitted by ^{8}Li. (auth)

4259 DETERMINATION OF SHORT-LIVED RADIONUCLIDES IN NEUTRON-ACTIVATED HUMAN HEAD-HAIR SAMPLES. Quittner, P. (Central Research Inst. for Physics, Budapest); Szabo, E.; Perneczki, G.; Major, A. J. Radioanal. Chem.; 5: No. 1, 133-40(May 1970).

The Al, Na, Mn, Cl, and Mg contents of human head-hair samples were determined by irradiating the samples in a thermal reactor and measuring their γ activity by scintillation techniques. The concentration variations of these elements in hair samples originating from the same and different persons were studied. (auth)

4260 RADIOTRACER STUDY OF THE REDUCTION OF NOBLE METALS BY AMALGAMATED COPPER POWDER. Park, K. S.; Gijbels, R.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem.; 5: No. 1, 43-9(May 1970).

A systematic study was made on the reducing power of amalgamated copper powder in hydrochloric acid solution for palladium, platinum, rhodium, iridium, gold, and silver. In order to apply this method to the activation analysis of palladium, platinum, and rhodium in industrial concentrates that contain a large amount of "base elements," the behavior of palladium, platinum, and rhodium in the presence of the "base elements" has also to be considered. (auth)

4261 SIMULTANEOUS DETERMINATION OF ZIRCONIUM AND HAFNIUM IN STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS. Rebagay, T. V.; Ehmann, W. D. (Univ. of Kentucky, Lexington). J. Radioanal. Chem.; 5: No. 1, 51-60 (May 1970).

A sensitive analytical technique was developed to determine zirconium and hafnium at the 1 and 0.01 ppM levels, respectively, in natural silicate matrices. The technique is based on the use of a Ge(Li) detector for high-resolution γ spectrometry following irradiation with thermal neutrons. Simultaneous separation of both elements is achieved by addition of only zirconium carrier and use of a strongly basic anion-exchange resin. Hafnium was shown to follow zirconium throughout the chemical procedures. The chemical yield of the separation procedure was determined for each sample by use of an automated fast-neutron activation analysis system, which obviated the need to convert the separated zirconium to a conventional gravimetric weighing form. The method was applied to the analysis of a variety of standard rocks and related natural materials. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 4907.

Chemical Properties

Refer also to abstracts 4339, 4342, 4378, and 4394.

4262 (SRARI-P-100) KINETICS AND MECHANISM OF INTERACTION BETWEEN AMERICIUM(III), (V), (VI), AND PEROXYDISULPHATE-IONS IN NITRIC ACID SOLUTIONS. Ermakov, V. A.; Timofeev, G. A.; Rykov, A. G.; Yakovlev, G. N.; Chistyakov, V. M. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

The kinetics of the reaction between americium(III), (V), (VI) and peroxydisulfate ions in 0.1 to 3.0 mole solutions of nitric acid in the range of 45 to 72°C were studied. A mechanism was proposed that is characterized by the occurrence of competing processes: americium(III) and (V) oxidizing and americium(VI) reducing with the products of peroxydisulfate ion thermal decomposition. (auth)

4263 ABSORPTION SPECTRA OF TRIVALENT URANIUM IN FUSED ALKALI CHLORIDES. Suzuki, Shin; Sato, Akiko; Tanaka, Koichi (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 35: No. 6, 589-93(Jun 1971). (In Japanese).

The absorption spectra of U(III) in fused LiCl, KCl, and CsCl were measured in the spectrum range from 30,000 to 7,000 cm^{-1} at various temperatures between 700 and 890°C. The visible and near infrared spectra of U(III) in these solutions depend largely upon the solvent cations radius and it is considered that this variation is due to the difference in the coordination structure of U(III) in each solution. The coordination structures of U(III) were attempted to infer from the following investigations; the significant differences in the chemical properties of fused LiCl, KCl, and CsCl, the similarity of the chemical properties of the coordination structures of U(III) with those of Pu(III) and Am(III) having the known coordination structures, and a comparative tendency of the systematic difference in the absorption spectra of U(IV) in solid state and fused alkali chlorides with that of U(III). It was assumed, consequently, that U(III) in fused CsCl and KCl media is coordinated with six chloride ions, and in fused LiCl, the coexistence of two species of U(III) coordinated with six chloride ions or less is reasonable. (auth)

4264 CAESIUM BEHAVIOUR IN LIQUID SODIUM: THE EFFECT OF CARBON. Clough, W. S.; Wade, S. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 25: No. 9, 445-56(Sep 1971).

From previous thermodynamic calculations and experimental work, cesium was identified as the most volatile major fission product with respect to release from liquid sodium into the gas phase. Sorption of the cesium by graphite was shown to be very effective in reducing the volatility of the cesium, and the formation of stable cesium–graphite compounds reduced the escaping tendency of cesium to less than that of iodine in liquid sodium. The cesium formed two compounds, one of which was relatively unstable in liquid sodium and was probably a surface adsorption compound. The more stable fraction of the adsorbed cesium was probably a lamellar cesium–graphite compound and was almost fully stable in vacuum at 500°C in the absence of sodium. The rate of reaction for the breakdown of the more stable cesium–graphite compound in sodium was measured over a range of temperatures and the corresponding activation energy was calculated. Graphite was found to be equally effective for cesium sorption when used in the gas phase above the liquid sodium. Charcoal was shown to be even more efficient than graphite in trapping cesium, and the cesium–charcoal compound which was formed was almost fully stable in sodium at 500°C and in air at the same temperature. Pre-treatment of the charcoal with sodium at 500°C for 3 days had little effect on its performance with respect to cesium sorption. (auth)

4265 BROMINE BEHAVIOUR IN FAST REACTORS. Clough, W. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 25: No. 9, 417-23(Sep 1971).

The chemical state of fission product bromine released from a fast reactor is predicted from thermodynamic calculations. By analogy with iodine the bromine is predicted to partition preferentially into the liquid sodium after release from a fast reactor fuel can. In experiments that measured the degree of removal by liquid sodium of ^{82}Br deposited on a stainless steel surface, the bromine was shown to be adsorbed on the surface at temperatures below 500°C and the partition coefficient for bromine between the steel surface and the liquid sodium was measured over a range of temperatures up to 500°C. Above 500°C, at the concentration of interest in a fast reactor release, neither prolonged baking nor residence time of the sodium in contact with the bromine on the surface had any great effect on the removal of the activity into the liquid sodium. (auth)

4266 BEHAVIOUR IN THE ATMOSPHERE OF THE AEROSOL FROM A SODIUM FIRE. Clough, W. S.; Garland, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 25: No. 9, 425-35(Sep 1971).

The chemical form of sodium released from a fast reactor into the atmosphere in accident conditions is predicted. The reaction of the sodium with oxygen, water vapor and carbon dioxide is discussed and calculations are made of both the final chemical state of the sodium and the rate of formation of the stable compounds. The size of the aerosols formed is shown to be a function of chemical form and relative humidity, and the effect of each is demonstrated in representative calculations. The calculations show that the reaction of sodium with other constituents of the atmosphere modifies the residence time and the deposition characteristics of the resulting sodium aerosol. (auth)

4267 BEHAVIOUR OF BARIUM AND STRONTIUM FISSION PRODUCTS IN LIQUID SODIUM. Clough, W. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 25: No. 9, 437-43(Sep 1971).

A knowledge of the behavior of fission products in liquid sodium is important in the consideration of both the safety and the economic aspects of fast reactor operation. In normal operation the information can be used to predict the fate of fission products released into the sodium (e.g., plate out on walls or transport to trapping systems). In accident conditions the vapor pressure of

the fission product in the sodium may be the rate-determining step for its release to the environment. The behavior of the fission product with respect to both transport through liquid sodium and vaporization from the sodium is mainly controlled by its chemical form. Thermodynamic calculations are presented, which indicate that both strontium and barium are likely to be present as the oxide in reactor-grade sodium. The volatility of the alkaline earth oxides is expected to be very low in reactor sodium but lack of basic data on their activity coefficients in liquid sodium prevents their vapor pressures from being calculated exactly. An apparatus is described in which the relative volatility of sodium and strontium was measured at the temperature, concentration, and level of sodium purity relevant to fast reactor application. As expected, the volatility of the strontium was found to be very low at 500°C and escape of the alkaline earth fission products to the gas phase is not likely to present an important hazard in normal operation or accident conditions. Further results are presented, which show that transport of a small fraction of the strontium and barium fission products (to cooler sections of the system and cold traps) is to be expected in a fast reactor system. (auth)

4268 STUDY OF THE HYDROLYSIS OF NITROSONITRATE COMPLEXES OF RUTHENIUM BY THE METHOD OF HIGH VOLTAGE ELECTROPHORESIS. Zaitsev, B. A.; Shevelkina, T. S. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 830-3(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 860-4(Nov-Dec 1970).

A separation of the ionic forms of nitrosoruthenium was conducted by the method of high-voltage paper electrophoresis in a 0.1 M solution of sodium nitrate in the interval of pH 1 to 4.5. The regions of existence of the cationic and anionic forms of nitrosoruthenium were determined. It was shown that at pH < 2.5, nitrosoruthenium exists in the form of cationic forms with a charge of +1, +2, +3, and neutral forms. The anionic forms of nitrosoruthenium appear at pH > 2 and their content increases sharply when the pH is raised to 3.5. At pH ≥ 3.5 the sorption of nitrosoruthenium by the paper increases. Since the content of cationic forms decreases regularly with increasing pH, while that of anionic forms increases, it may be assumed that neutral and anionic forms of nitrosoruthenium are sorbed. The cation with a charge of +3 detected in the solutions can be considered as pentaaquanitrosoruthenium – $[RuNO(H_2O)_5]^{3+}$. Each of the other peaks obtained on the electrophoretograms evidently is formed by a mixture of one of the hydrolysis products of this complex with like charged nitrate complexes, hydrolyzed to different degrees. (auth)

4269 THERMODYNAMICS FOR THE FORMATION OF AMERICIUM–IMINODIACETIC ACID COMPLEXES AS DETERMINED BY SPECTROPHOTOMETRIC AND pH TECHNIQUES. Bell, J. T.; Baybarz, R. D.; Helton, D. M. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 9, 3077-86(Sep 1971).

The changes in the spectra and the pH of four solutions of Am^{3+} and iminodiacetic acid (IDA) were observed over the 15 to 90°C range. Equilibrium constants for the reaction forming the 1 : 1 complex $AmIDA^+$ were determined, and ΔH for the reaction was calculated to be 6.9 kcal $mole^{-1}$ from the linear plots of ln K vs. 1/T. The free energy decreases from 3 to 2 kcal $mole^{-1}$ while the entropy is constant, 13.1 ± 3.7 eu, over the 15 to 90°C range. The heat of reaction for the first ionization of IDA was determined to be –1 kcal $mole^{-1}$, and the second ionization of IDA was indicated to also be exothermic. Therefore, the ionization of IDA cannot induce the endothermic character of reaction forming the 1 : 1 complex. The thermodynamics is likely controlled by the heat of dehydration of Am^{3+} which is expected to be about 200 kcal $mole^{-1}$. (auth)

4270 URANIUM(VI)–1-HYDROXY-2-NAPHTHOIC ACID CHELATE. A SPECTROPHOTOMETRIC STUDY. Pant, Amar N.; Soni, R. N.; Gupta, S. L. (BITS, Rajasthan, India). J. Inorg. Nucl. Chem.; 33: No. 9, 3202-5(Sep 1971).

Using the method of Vosburg and Cooper (1941) it was confirmed that only one chelate was formed and the color formation was instantaneous with no change in absorbance up to 24 hr. The chelate showed maximum absorbance between pH 4.4 and 4.8, the molecular composition was found to be 1 : 1, and the ratio of ligand to metal was found to be one. The stability constants of the chelate at various ionic strengths are tabulated. By the method of extrapolation, the thermodynamic stability constant at zero ionic strength was found to be log K = 3.88 at 30°C. From measurements at different temperatures values of log K, ΔG and ΔS were obtained and are tabulated. It was shown that ions like NO_3^-, SO_4^{2-}, Cl^-, CNS^-, Br^-, I^-, S^{2-}, Cd^{2+}, Zn^{2+}, W^{6+}, Ba^{2+}, Ca^{2+} did not interfere, but Ni^{2+}, Co^{2+}, Mn^{2+}, and Th^{4+} interfered only when present in slight excess. Fe^{3+}, Cu^{2+}, Al^{3+}, and Ti^{4+} as well as organic acids interfered even when present in minute quantities. (UK)

4271 SUBSTITUENT EFFECTS ON THE PHOTOCHEMICAL REACTION RATES OF THE URANYL–ALCOHOL SYSTEM. Matsushima, Ryoka; Sakuraba, Shukichi (Shizuoka Univ., Hamamatsu, Japan). J. Amer. Chem. Soc.; 93: No. 21, 5421-3(20 Oct 1971).

The substituent effects of the substrate (alcohol) on the photochemical reaction rates of the uranyl–alcohol system were investigated on the basis of both the fluorescence quenching and the photoredox data. There was a parallel relation between the quenching and the photoredox reaction rates. Plots of the logarithm of the photoredox quantum yield as a function of the polarity of the substrate, $\Sigma\sigma^*$ (sum of the Taft σ^* values), showed a linear relationship, with $\rho^* = -1.1$. The steric effect on the rates appeared to be less important. A mechanism involving α-hydrogen abstraction in the rate-determining step was suggested from the kinetic isotope effects and the markedly small rate with tert-butyl alcohol, as well as from the ρ^* value of –1.1. (auth)

4272 INTERACTION OF URANIUM WITH CHLORO-ORGANIC MATERIALS. Beard, J. H.; Orman, S. (United Kingdom Atomic Energy Agency, Aldermaston, Eng.). J. Nucl. Mater.; 41: No. 3, 320-6(Dec 1971).

The effect of uranium of a series of organic chlorine-containing materials was investigated at 100°C. None of the materials reacts with uranium and this lack of reactivity is unaffected by the addition of water. α-Chlorinated toluenes are polymerized at elevated temperatures (90 to 100°C) in the presence of uranium by a Friedel–Crafts type reaction. Uranium metal has some slight effects on other Friedel–Crafts reactions. (auth)

4273 URANIUM(IV) COMPLEXING WITH PROPIONATE IONS. Lobanova, T. S.; Dunaeva, K. M.; Ippolitova, E. A. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 3, 321-3(May-Jun 1971). (In Russian).

Stability constants for the ions $[U(Prop)]^{3+}$ and $[U(Prop)_2]^{2+}$ in the system benzene – water – propionic acid were determined by the distribution method at 20°C and ionic strength 2 (perchlorate solution). (auth)

4274 FORMATION OF A COMPLEX OF THORIUM WITH CAPRINOHYDROXAMIC ACID. Obukhova, M. E.; Voden, V. G.; Pushlenkov, M. F. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 877-8(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 901-3(Nov-Dec 1970).

The composition of complex compounds of thorium with caprinohydroxamic (decanohydroxamic) acid was studied. From experimental results according to the method of isomolar series it was concluded that two types of compounds were formed, $Th(NO_3)_2R_2$ and $Th(NO_3)R_3$. (D.H.M.)

4275 OXIDATION OF MERCURY(I) BY NEPTUNIUM(VII). Thompson, Mark A.; Sullivan, J. C.; Deutsch, Edward (Argonne National Lab., Ill. Univ. of Chicago). J. Amer. Chem. Soc.; 93: No. 22, 5667-9(3 Nov 1971).

The empirical form of the rate law for the oxidation of Hg(I) by Np(VII) is $-d[Np(VII)]/dt = k'[Np(VII)][Hg(I)]$, where $k' = k_1 + k_2[H^+]$. At 25° and $\mu = 1.0$ M, $k_1 = 28.1 \pm 0.7$ M^{-1} sec^{-1} and $k_2 = 13.4 \pm 1.4$ M^{-2} sec^{-1}. The respective apparent activation energies are 12.2 ± 0.3 and 8.3 ± 0.8 kcal/mol. These results are consistent with Sykes' correlation of Hg(I) oxidation rate laws with the oxidation potential of the oxidant. Arguments are presented which indicate that, at least for the k_2 path, the rate of Np(VII) reduction is not sensitive to the nature of the reductant. (auth)

4276 AMINOPOLYCARBOXYLIC ACID COMPLEXES OF THE Np(IV) ION. Eberle, S. H.; Paul, M. Th. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 33: No. 9, 3067-75(Sep 1971). (In German).

The composition and the formation equilibria of several Np(IV)–aminopolycarboxylic acid complexes were investigated by spectrophotometry. The logarithms of the stability constants are: N-hydroxyethyliminodiacetic acid $\beta_1 = 12.97$; $\beta_2 = 23.72$; Nitrilotriacetic acid $\beta_1 = 17.28$; $\beta_2 = 32.06$; N-hydroxyethylethylenediamintriacetic acid $\beta_1 = 20.82$; $\beta_2 = 33.59$; Ethylenediaminetraacetic acid $\beta_1 = 24.55$; Diethylenetriaminpentaacetic acid $\beta_1 = 30.33$. With the first and the third ligand Np(IV) forms a mixed complex. (auth)

4277 COMPLEXES OF URANYL β-DIKETONES WITH AROMATIC AMINE N-OXIDES. Subramanian, M. S.; Manchanda, V. K. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem.; 33: No. 9, 3001-9(Sep 1971).

A series of complexes of uranyl β-diketones with pyridine N-oxide (PyNO) and its 4-substituted derivatives (4z · PyNO) were isolated by solvent extraction. The β-diketones used were thenoyl trifluoroacetone (TTA), benzoyl trifluoroacetone (BTFA), benzoylacetone (BA), dibenzoylmethane (DBM), trifluoroacetylacetone (TFAA), and hexafluoroacetylacetone (HFAA), the 4-substituents of the amine N-oxide ranging from the electron withdrawing NO_2 and Cl to the electron releasing CH_3 and OCH_3 groups. The analytical data for these complexes lead to their formulation as $UO_2(\beta\text{-diketone})_2$ S where S = PyNO or 4z · PyNO. They are monomeric in benzene and non-electrolytes. Characteristic infrared stretching frequencies and proton magnetic resonance spectra of the complexes are reported and discussed in relation to the "substituent parameter" (σ^+) of the amine N-oxide. (auth)

Isotope Effects and Exchange

4278 PHOTOIONIZATION OF ALIPHATIC KETONES AND ALCOHOLS. Potapov, V. K.; Sorokin, V. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 355-6(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

The vibrational spectra of ketone and methyl alcohol cation radicals and the decomposition processes that take place during the photoionization of methyl, ethyl, and tert-butyl alcohols were studied. The relative intensity of the vibrations does not change when the hydrogen atom in the OH groups is substituted by a deuterium atom (CH_3OD), and increases when the three hydrogen atoms in the methyl group are substituted by the deuterium atoms (CD_3OH). This indicates that there is an increase in the equilibrium distance of the C–O bond in the cation radical in the transition from CH_3OH to CD_3OH. (D.H.M.)

4279 INFRARED SPECTRA OF SOME ALKYL PLATINUM COMPOUNDS. PART II. ASSIGNMENT OF THE CH STRETCHING MODES OF A METHYL GROUP. Morrow, B. A.; Beauchamp, Y. (Univ. of Ottawa). Can. J. Chem.; 49: No. 18, 2921-5(15 Sep 1971).

Several isotopically substituted triphenylphosphine stabilized dimethyl platinum compounds of the type $(Ph_3P)_2PtMe_2$ where Me = CH_3, CH_2D, CD_2H, and CD_3 were prepared and their infrared spectra in the CH and CD stretching regions were examined. The assignments of the stretching vibrations of the methyl group were confirmed by means of an application of the Average Rule for isotopically substituted species. The possible application of the Average Rule as a general method for assigning CH stretching modes is discussed and it is suggested that the method could be used to confirm some recently proposed reassignments of the traditional Fox and Martin assignments. The method may also be used by surface chemists as a means of determining the number of hydrogen atoms in an adsorbed XH_n species. (auth) (Canada)

4280 VIBRATIONAL FREQUENCY ASSIGNMENTS OF ISOTOPICALLY DIFFERENT FORMS OF NITRATE ION IN IONIC NITRATE CRYSTALS. Brooker, M. H.; Irish, D. E. (Univ. of Waterloo, Ont.). Can. J. Chem.; 48: No. 8, 1198-1201(15 Apr 1970).

Infrared and Raman spectra of powdered ionic nitrates contain low intensity vibrational bands, which are assigned to isotopically different species. Bands at ~($\nu_1 - 20$) and ~($\nu_4 - 13$) cm^{-1} are assigned to the $^{14}N^{16}O_2{}^{18}O^-$ ion whereas the band at ~($\nu_2 - 20$) cm^{-1} is assigned to the $^{15}N^{16}O_3^-$ ion. Failure of the ratio of band intensities to agree with predicted isotopic ratios is discussed. (auth) (Canada)

4281 MEASUREMENT OF THE CRITICAL TEMPERATURE IN $MnCl_2.4H_2O$, $MnBr_2.4H_2O$, AND THEIR DEUTERATED MODIFICATIONS. Turrell, B. G.; Yue, C. L. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: No. 19, 2520-4(1 Oct 1971).

Some λ-type discontinuities were observed in $\partial\chi/\partial T$, χ being the magnetic susceptibility at temperature T, in single crystal specimens of $MnCl_2 \cdot 4H_2O$ and $MnCl_2 \cdot 4D_2O$ and polycrystalline specimens of $MnBr_2 \cdot 4H_2O$ and $MnBr_2 \cdot 4D_2O$. Assuming this discontinuity occurs at the critical temperature T_c, values of $T_c = 1.611 \pm 0.002$ K for $MnCl_2 \cdot 4H_2O$, $T_c = 1.545 \pm 0.002$ K for $MnCl_2 \cdot 4D_2O$, $T_c = 2.117 \pm 0.002$ K for $MnBr_2 \cdot 4H_2O$, and $T_c = 2.093 \pm 0.002$ K for $MnBr_2 \cdot 4D_2O$ were obtained. (auth) (Canada)

4282 VIBRATIONAL SPECTRA AND FORCE CONSTANTS OF SYMMETRICAL ROTATION. VIII. RAMAN AND INFRARED SPECTRA OF H_3SiBr AND D_3SiBr. Buerger, H. (Technische Univ., Brunswick); Cichon, J.; Ruoff, A. Z. Naturforsch.; 26b: No. 10, 1068-9(Oct 1971). (In German).

The basic vibrations as well as the fine structure of the E vibration were calculated for H_3SiBr and D_3SiBr. (M.C.G.)

4283 PRIMARY KINETIC ISOTOPE EFFECTS AND THE NATURE OF HYDROGEN-TRANSFER TRANSITION STATES. THE REACTION OF A SERIES OF FREE RADICALS WITH THIOLS. Pryor, William A.; Kneipp, Kenneth G. (Louisiana State Univ., Baton Rouge). J. Amer. Chem. Soc.; 93: No. 21, 5584-6(20 Oct 1971).

A maximum in the isotope effects for a homologous series of hydrogen atoms transfer reactions is reported. The reactions studied involved the abstraction of a hydrogen atom from the SH position of an isotopically labeled thiol: $Q\cdot + RSH^* \rightarrow QH^* + RS\cdot$ and $Q\cdot + PhSH^* \rightarrow QH^* + PhS\cdot$ where $Q\cdot$ is any organic free radical; RSH^* is an isotopically labeled aliphatic thiol; and $PhSH^*$ is labeled thiophenol. (D.H.M.)

4284 PHOTOADDITION REACTIONS OF SOME ELECTRON-DEFICIENT ACYCLIC OLEFINS WITH NUCLEOPHILES. STUDIES ON THE SCOPE AND MECHANISM. Happ, John W.; McCall, M. T.; Whitten, David G. (Univ. of North Carolina, Chapel Hill). J. Amer. Chem. Soc.; 93: No. 21, 5496-5501 (20 Oct 1971).

The photochemical addition of alcohols, water (H_2O and D_2O), and ether to the acyclic olefinic bond of quaternary salts of pyridylethylenes is reported. These reactions are initiated by attack of the oxygen compound on the excited singlet state of the electron-deficient olefin. Decay of the excited state complex leads to alcohols or ethers when attack is by water or alcohols, respectively. The addition of ethers proceeds by a radical-type path (likely by electron transfer followed by proton transfer) to yield α-substituted ethers. (auth)

4285 CHROMIUM(IV) OXIDATION OF PRIMARY AND SECONDARY ALCOHOLS. Rahman, Matiur; Rocek, Jan (Univ. of Illinois, Chicago). J. Amer. Chem. Soc.; 93: No. 21, 5455-62(20 Oct 1971).

The approach previously used to study the chromium(IV) oxidation of cyclobutanol was developed into a general method for the investigation of the properties of chromium(IV) as an oxidant. The study of the reaction kinetics, product yield, and the effect of the presence of free-radical trapping agents supports the conclusion that chromium(IV) reacts rapidly with primary and secondary alcohols but is unreactive toward tert-butyl alcohol. The reaction is a one-electron oxidation leading to a free radical, probably $R_2\dot{C}OH$. The radical can be further oxidized by one of the oxidants present, but its rate of oxidation, particularly with chromium(VI), is slow enough to allow for sufficient accumulation permitting a bimolecular destruction of two radicals. The relative oxidation rates of a number of alcohols by chromium(IV) have been determined. The Taft ρ^* value of −0.85 found for primary alcohols indicates that the electronic requirements of the chromium(IV) oxidation are similar to those of chromium(VI) oxidations. The primary isotope effect for the oxidation of 2-deuterio-2-propanol is 1.9, a value of the same magnitude as found for some other one-electron oxidations of alcohols. (auth)

4286 OXIRENE INTERMEDIATE IN THE REACTION OF SINGLET METHYLENE WITH CARBON MONOXIDE. Montague, Derek C.; Rowland, F. S. (Univ. of California, Irvine). J. Amer. Chem. Soc.; 93: No. 21, 5381-7(20 Oct 1971).

Singlet $^{14}CH_2$ from the photolysis of $^{14}CH_2CO$ reacts with CO with an isotopic carbon atom exchange to form ^{14}CO. At higher pressures, the intermediate can be collisionally stabilized. This intermediate is presumably oxirene, although there is no evidence for a stabilized adduct other than [^{14}C] ketene. While CO is capable of suppressing the reactions of $^3CH_2$ in mixed $^1CH_2/^3CH_2$ systems, the collision efficiency of O_2 toward $^3CH_2$ is 10^4 times greater than that of CO. The collision efficiency with CO of $^3CH_2$ is substantially less than is that of $^1CH_2$ with CO. A simple kinetic analysis permits an estimate of 0.10 for the ratio of rate constants for reaction of $^1(^{14}CH_2)$ with CO and with ketene. Approximately half of the $^{14}CH_2$ + CO adducts are collisionally stabilized at 840 torr of carbon monoxide. (auth)

4287 NONEQUILIBRIUM KINETIC ISOTOPE EFFECTS AND OTHER ASPECTS OF MODELS FOR HCl AND DCl ELIMINATION FROM CHLOROETHANE-d_0, -d_3, AND -d_5. Clark, W. G.; Setser, D. W.; Dees, K. (Kansas State Univ., Manhattan). J. Amer. Chem. Soc.; 93: No. 21, 5328-35(20 Oct 1971).

The nonequilibrium kinetic isotope effect for chemically activated chloroethane-d_3 and chloroethane-d_0 molecules with 91 kcal $mole^{-1}$ of energy was measured as 2.1. The nonequilibrium and thermal equilibrium kinetic isotope effects are in good agreement with calculated values using the RRKM formulation of unimolecular reactions and a four-centered model for the activated complex described by bond orders having the H (D) weakly bound in the ring. Recent energy-partitioning data from the literature for HF elimi-

nation from CH_3CF_3 suggest that the carbon–carbon bond order is significantly less than two at the activated complex configuration; hence, total bond order is not conserved during the HX elimination reaction. Calculated thermal unimolecular rate constants are used to illustrate the effect of pressure upon the Arrhenius activation energies for C_2H_5Cl, CD_3CH_2Cl, and C_2D_5Cl. Pressures higher than those reported in the literature are needed to deduce threshold energies from the measured Arrhenius activation energies, and the correction could affect $E_D^0 - E_H^0$ by ≃0.5 kcal mole^{-1}. The influence of anharmonicity upon chemically activated nonequilibrium kinetic isotope effects was examined in model calculations; reasonable estimates of anharmonicity constants did not change the ratio of rate constants. (auth)

4288 SPECTROSCOPY OF CARBON MOLECULES. IV. C_4, C_5, C_6, (AND C_9). Thompson, K. R.; DeKock, R. L.; Weltner, W. Jr. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 93: No. 19, 4688-95(22 Sep 1971).

The carbon molecules C_4, C_5, C_6, and perhaps C_9, were formed in argon matrices by the reaction of C, C_2, and C_3. Highly enriched ^{13}C graphite was vaporized to form the isotopically substituted molecules. Analysis of the ir spectra of "pure" and mixed-isotope molecules made possible definite vibrational assignments for the Σ_u^+ frequencies. For $^{12}C_4$, $^{12}C_5$, and $^{12}C_6$ these are 2164; 1952, 1544; and 1997, 1197 cm^{-1}, respectively. The data on each molecule, including mixed-isotope species, were used to calculate stretching force constants. C_4 was found to have a strong C≡C outer bond with f = 16.5 mdyn/Å, in general agreement with theory. The force constants for the two outer bonds of C_6 were reliably determined to be 11.9 and 8.1 mdyn/Å. Larger carbon molecules were formed but not identified. (auth)

4289 SPECTROSCOPY OF TITANIUM OXIDE AND TITANIUM DIOXIDE MOLECULES IN INERT MATRICES AT 4°K. McIntyre, N. S.; Thompson, K. R.; Weltner, W. Jr. (Univ. of Florida, Gainesville). J. Phys. Chem.; 75: No. 21, 3243-9(14 Oct 1971).

The lowest-lying $^3\Pi$ state of TiO was observed as a weak system at 8406 Å in absorption in a neon matrix at 4°K. The ultraviolet bands recently observed by Pathak and Palmer in the gas phase and attributed to TiO^- were also observed at 3100 Å in a neon matrix. As in the gas phase, the vibrational progressions seem to be due to two overlapping systems which are strongly perturbing each other so that a definite analysis for either $Ti^{16}O$ or $Ti^{18}O$ was not possible. The electronic transitions of TiO in the visible region were also observed in krypton and xenon matrices. The infrared spectrum of trapped TiO_2 yields the stretching frequencies, and a bond angle of ~110° is obtained from Ti isotope splittings. An emission system of TiO_2 was observed at ~5300 Å, terminating in the ground state. (auth)

4290 TRIPLET STATE OF BENZALDEHYDE. Koyanagi, Motohiko; Goodman, Lionel (Rutgers–The State Univ., New Brunswick, N. J.). J. Chem. Phys.; 55: No. 6, 2959-76(15 Sep 1971).

The phosphorescence spectra of benzaldehyde-h_6, -$1d_1$, -$4d_1$, -3, $5d_2$ and -d_6 were studied optically in close packed matrices (acetophenone and methyl benzoate) and relaxed matrices (methylcyclohexane and perfluoro-n-hexane) at 4.2°K. All the spectra were sharp and could be analyzed vibrationally. In the close packed matrices, of the 11 possible out-of-plane (a'') fundamentals, nine were observed in Herzberg–Teller borrowing of intensity. The strongest modes are the aldehyde-H wag, the CHO torsion and CHO wag, and their intensities were found to be stronger than those of any totally symmetrical bands including the origin band. Two and 3 quanta of aldehyde-H-wag and CHO-torsional modes were found with intensity alternation. In addition to this intensity alternation, the lack of long sequences of any nontotally symmetric mode and the analysis of the Franck–Condon envelope show that the triplet benzaldehyde does not deviate far from the ground state geometry. It was concluded that it is coplanar or nearly so. Deuteration effects on the vibronic intensities are remarkable. The long lifetime, ~4×10^{-2} sec at 4.2°K, supports a planar geometry for the triplet. The large change of lifetime and spectral intensity on substitution of the aldehyde hydrogen by deuterium shows that the aldehyde H plays an important role in the vibronic interaction. In the relaxed matrices most of the out-of-plane fundamentals were too inactive to be identified in the phosphorescence. The only out-of-plane mode clearly identified was the fundamental CHO-torsional mode and its overtone. Higher overtones were not found. Most of the intensity was in the 0–0 band and the ν(C = O) progression, which was longer than in the close packed matrices. Also active were in-plane modes such as $\delta(\phi$–CHO), $\nu(\phi$–CHO), ν_{11}, $\nu_{9\,a}$, and $\nu_{8\,a}$. The short lifetime in the relaxed matrices (fully 20 times shorter than in the close packed matrices), ~2×10^{-3} sec at 1.68°K, without appreciable deuteration effect established that the triplet benzaldehyde is highly nonplanar with the aldehyde group twisted out of plane. It was concluded from the lifetime that the twist angle exceeds 60°. The vapor phosphorescence resembles the relaxed matrix phosphorescence, but with still reduced lifetime. In the free molecule the aldehyde group in the benzaldehyde triplet was also strongly out of plane. (auth)

4291 LOW FREQUENCY VIBRATIONS IN MOLECULAR SOLIDS. XII. LOW FREQUENCY MODES AND BARRIERS TO INTERNAL ROTATION OF SOME DIMETHYL COMPOUNDS OF ELEMENTS IN GROUP VI. Durig, J. R.; Player, C. M. Jr.; Bragin, J.; Li, Y. S. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 55: No. 6, 2895-2905(15 Sep 1971).

The far infrared spectra of solid CH_3OCH_3, CD_3OCH_3, CD_3OCD_3, CH_3SCH_3, CH_3SeCH_3, and CH_3TeCH_3 were recorded between 350 and 33 cm^{-1}. The B_2 and A_2 torsional frequencies were assigned at 268 and 244, 245, and 208, 207, and 182, 247 and 210, 207 and 175, and 185 cm^{-1} for the above molecules at liquid nitrogen temperatures. The barriers calculated from these assignments are 3.50, 3.48, 3.39, 3.22, 2.40, and 2.27 kcal/mole, respectively. The lattice bands observed in the infrared spectra of the isotopic dimethyl ethers were assigned to librational and translational motion on the basis of the deuteration shifts. The infrared spectra of the sulfide and selenide in the region of the lattice frequencies are similar and a tentative assignment of these bands to librational and translational motions is presented based on the expected shift factors. The infrared lattice spectrum of dimethyl telluride is also presented. (auth)

4292 PHOTOCHEMICALLY INDUCED ISOTOPE EXCHANGE BETWEEN IODOBENZENE AND MOLECULAR IODINE. Levy, A. (Nuclear Research Centre, Negev, Israel); Meyerstein, D.; Ottolenghi, M. J. Phys. Chem.; 75: No. 21, 3350-4(14 Oct 1971).

The photochemical isotopic exchange between iodobenzene and radioactive molecular iodine ($I^{131}I$) was studied in methylcyclohexane solutions. The limiting exchange yields, ϕ_{EX}^0, measured at several excitation wavelengths in the uv range were found to be identical with the corresponding deiodination limiting yields, ϕ_{DE}^0. This observation and a study of the effects of dissolved oxygen and iodine concentrations suggest that the exchange is initiated by photocleavage of iodobenzene to phenyl (Ph·) and iodine radicals, with O_2 and I_2 competing in the scavenging of Ph· ($k_{I2+Ph}/k_{C2+Ph.}$ = 2.1 ± 0.5). The photocleavage of iodobenzene was found to be wavelength dependent in the near-uv range (e.g., 334 and 365 nm), where part of the absorption leads directly to the iodobenzene triplet. It is suggested that dissociation takes place from the lowest excited singlet, but practically not from the triplet state. It is shown that iodine atoms, produced by selective excitation in the visible range, do not exchange with iodobenzene. Neither does excitation of the charge-transfer (CT) complex between iodobenzene and iodine lead to exchange or deiodination. (auth)

4293 ROTATIONAL DIFFUSION OF SPHERICAL-TOP MOLECULES IN LIQUIDS. II. REORIENTATION IN LIQUID METHANE AND SOLUTIONS OF METHANE IN LIQUID NOBLE GASES. McClung, R. E. D. (Univ. of Alberta, Edmonton). J. Chem. Phys.; 55: No. 7, 3459-67(1 Oct 1971).

Numerical calculations of reorientational correlation functions and spectral densities for spherical-top molecules in the extended rotational diffusion models are presented. The correlation functions obtained from Fourier transformation of the ν_3 infrared band contours for CH_4 and CD_4, in pure liquid form and in dilute solutions in liquid noble gases, are compared with calculated correlation functions. This comparison suggests that rotational energy transfer is much more rapid in the neat liquid methanes than in liquid noble gases, and allows an estimate of the anisotropy of the intermolecular potential experienced by the methane molecules. (auth)

4294 STRUCTURAL EFFECT IN SOLVOLYTIC REACTIONS. IV. RATES AND PRODUCTS IN THE ACETOLYSIS OF SUBSTITUTED 3-PHENYL-2-BUTYL BROSYLATES. NATURE OF THE REACTION PATHWAY IN THE ACETOLYSIS OF SECONDARY ALKYL ARENESULFONATES. Brown, Herbert C.; Kim, C. J. (Purdue Univ., Lafayette, Ind.). J. Amer. Chem. S Soc.; 93: No. 22, 5765-73(3 Nov 1971).

An objective approach to the magnitude of the rate acceleration attributable to phenyl participation in acetolysis of threo-3-phenyl-2-butyl brosylate was developed. This approach involves determination of the rates and products of acetolysis of a series of substituted threo-3-phenyl-2-butyl brosylates and determination of the Hammett plot for the unassisted rate (k_s) component from the k_s values for those compounds containing deactivating substituents, followed by evaluation of the unassisted rate of the parent compound. This experimental approach yields a factor of 3 for the acceleration of the rate of acetolysis of 3-phenyl-2-butyl arenesulfonate. This small value confirms an earlier estimate which re-

sulted in the conclusion that such a small rate acceleration did not appear to be compatible with the proposed mechanism involving the formation of a stabilized phenyl-bridged intermediate competitively with the formation of an open cation. Considerable cross-over would be expected in such a mechanism. However, the data reveal a a precise correlation between rates and products. Therefore, cross-over is not significant. It follows that in the acetolysis of secondary β-arylalkyl derivatives the aryl-participated pathway must be essentially independent of the competing pathway—without significant crossover between the two paths. This apparently requires that the competing pathway must be far from limiting, implying participation by solvent sufficiently important as to render cross-over unimportant. This conclusion represents a major break with the original position that the acetolysis of secondary alkyl arenesulfonates approaches limiting in character and eliminates the apparent anomaly referred to above. Some mechanistic considerations are examined in an attempt to provide a consistent interpretation of the phenomena observed in the acetolysis of secondary alkyl arenesulfonates. (auth)

4295 ISOTOPE EFFECTS IN THE PHOTOIONIZATION YIELDS AND IN THE ABSORPTION CROSS SECTIONS FOR METHANOL, ETHANOL, METHYL BROMIDE, AND ETHYL BROMIDE. Person, James C.; Nicole, Paul P. (Argonne National Lab., Ill.). J. Chem. Phys.; 55: No. 7, 3390-7(1 Oct 1971).

The values of the absorption cross section σ and the photoionization yield η (the probability that photon absorption produces ionization) were experimentally determined for CH_3OH and CD_3OD, C_2H_5OH and C_2D_5OD, CH_3Br and CD_3Br, and C_2H_5Br and C_2D_5Br at various photon energies in the energy range of 9.97 to 11.78, 10.32 to 11.78, 10.08 to 11.78, and 9.97 to 11.78 eV, respectively. In each case, there is increased ionization for the deuterated molecule over a part of the energy range studied. This increase is seen in the values of both η and the photoionization cross section, $\sigma_i(\sigma_i = \eta\sigma)$, and it is discussed as evidence for the competitive preionization of intermediate states. The effects of methyl substitution on σ and σ_i are also discussed, and ionization potentials are reported for each gas. (auth)

4296 PYROLYSIS OF THIO- AND ISOTHIOCYANATES. II. ETHYL THIOCYANATE. Barroeta, N.; Maccoll, Allan (Instituto Venezolano de Investigaciones Cientificas, Caracas. Christopher Ingold Labs., London). J. Amer. Chem. Soc.; 93: No. 22, 5787-90(3 Nov 1971).

The gas-phase thermolysis of ethyl thiocyanate was investigated in the pressure range 25 to 350 mm by a conventional, static, manometric technique. The least-squares Arrhenius equation for the elimination reaction is $k_1(sec^{-1}) = 10^{11.770\pm0.213} \exp(-40{,}510 \pm 576)/RT$ from 559 to 616°K. The values of the first-order rate constant are not affected by the nature of the walls or the surface to volume ratio of the reaction vessel, or by added olefinic inhibitors. The pyrolyses of ethyl-1, 1-d_2, and ethyl-d_5 thiocyanates were also studied under the above conditions yielding the following Arrhenius equations: ethyl-1,1-d_2, $k_1(sec^{-1}) = 10^{11.992\pm0.193} \exp(-41{,}295 \pm 517)/RT$; ethyl-$d_5$, $k_1(sec^{-1}) = 10^{12.334\pm0.178} \exp(-43{,}390 \pm 495)/RT$. The mass spectrometric analysis of the ethylene produced in the pyrolysis of ethyl-1,1-d_2 thiocyanate showed it to be 95.6% $CH_2{=}CD_2$. The above results are interpreted in terms of a homogeneous, unimolecular mechanism in which the hydrogen and the thiocyanate group are eliminated from adjacent carbon atoms. The transition state is regarded as a cyclic structure with very little charge separation. (auth)

4297 SILVER(I) ION CATALYZED REARRANGEMENTS OF STRAINED σ BONDS. VIII. DEUTERIUM ISOTOPE EFFECTS IN THE BOND REORGANIZATIONS OF TRICYCLO[4.1.0.$0^{2,7}$]-HEPTANES. Paquette, Leo A.; Wilson, Stanley E. (Ohio State Univ., Columbus). J. Amer. Chem. Soc.; 93: No. 22, 5934-6 (3 Nov 1971).

Isotope effects data for tricyclo[4.1.0.$0^{2,7}$]heptane and methyltricyclo[4.1.0.$0^{2,7}$]heptane are presented that make manifest the intimate details of bond reorganizations. (D.H.M.)

4298 ISOTOPE EFFECTS IN NUCLEAR MAGNETIC RESONANCE SPECTRA MODIFIED BY RARE-EARTH SHIFT REAGENTS. Smith, Gerard V.; Boyd, Walter A.; Hinckley, C. C. (Southern Illinois Univ., Carbondale). J. Amer. Chem. Soc.; 93: No. 23, 6319-20(17 Nov 1971).

When a mixture of light and heavy trans-verbenol was examined by NMR using Hinckley's reagent, the dipyridine adduct of trisdipivalomethanatoeuropium(III), concomitant with the expected shifts, a doubling of all hydrogen peaks occurred. Examination of a variety of alcohols and one aldehyde showed that the effect is quite general. (D.H.M.)

4299 LACK OF METHYL PARTICIPATION IN A NEOPENTYL ARYLSULFONATE SOLVOLYSIS. Schubert, W. M.; Henson, William L. (Univ. of Washington, Seattle). J. Amer. Chem. Soc.; 93: No. 23, 6299-6301(17 Nov 1971).

Relatively direct evidence that the methyl migration step and the rate-controlling step in the solvolysis of neopentyl 2,4-dinitrobenzenesulfonate in 97.3% trifluoroacetic acid are not the same was obtained by a method consisting of a comparison of the kinetic isotope effects produced by successive replacement of CH_3 by CD_3 with the CH_3–CD_3 migration in the solvolysis. Since there is no significant kinetic isotope effect, but nevertheless a distinct preference for CH_3 to migrate faster than CD_3, it was concluded that the migration step probably occurs after the rate-controlling step. (D.H.M.)

4300 STUDIES ON THE MECHANISM OF ISOTOPIC OXYGEN EXCHANGE AND REDUCTION OF FERRATE(VI) ION (FeO_4^{2-}). Goff, Harold; Murmann, R. Kent. (Univ. of Missouri, Columbia). J. Amer. Chem. Soc.; 93: No. 23, 6058-65(17 Nov 1971).

In basic media the rate of ^{18}O exchange between FeO_4^{2-} and water follows the law $R = k[FeO_4^{2-}]$, where $k = 1.62 \times 10^{-2}$ sec^{-1} at 25°, log A = 9.51 ± 0.79, and E_a = 15.4 ± 1.0 kcal/mole. In aqueous media the ion of 6+ Fe is FeO_4^{2-} and all oxygens are kinetically equivalent. Both water exchange and water oxidation are accelerated by dilute acid. Stoichiometric, kinetic, and ^{18}O studies were applied to the reaction of FeO_4^{2-} with H_2O, H_2O_2, and SO_3^{2-}, and the results are compared with other strong oxidizing agents. The reaction with H_2O_2 and SO_3^{2-} are quantitative and show simple stoichiometry. The reactions are first order in H_2O_2 and second order in SO_3^{2-}, but oxygen transfer from FeO_4^{2-} to the product (O_2 or SO_4^{2-}) occurs only in the latter case. (auth)

4301 ^{18}O ISOTOPIC INFRARED STUDY OF DIOXYGEN–TRANSITION METAL COMPLEXES. Nakamura, Akira; Tatsuno, Yoshitaka; Yamamoto, Masao; Otsuka, Sei (Osaka Univ. Nara Women's Univ., Japan). J. Amer. Chem. Soc.; 93: No. 23, 6052-8 (17 Nov 1971).

An ^{18}O isotopic infrared study of various dioxygen complexes, $Pt(O_2)(PPh_3)_2$, $M(O_2)(tert\text{-}BuNC)_2$ (M = Ni, Pd), and $RhX(O_2)L_2$ (tert-BuNC) (X = Cl, Br; L = PPh_3, $AsPh_3$) prepared with a heavy dioxygen mixture ($^{16}O_2$, $^{16}O{-}^{18}O$, and $^{18}O_2$) revealed the geometry of the O_2 coordination to be a side-on isosceles structure except in the Pd complex, where deviation from the isosceles structure was inferred. Approximate force constants of O–O (a_1) as well as M–O stretching vibrations (a_1 and b_1) were calculated on the simple triatomic isosceles local model (C_{2v}). The results indicate a marked reduction in the O–O stretching force constant upon coordination (3.0 to 3.5 mdyn/Å) relative to that of the free gaseous dioxygen (11.5 mdyn/Å). The M–O stretching force constants (2.1 to 3.2 mdyn/Å) were correlated with the reactivity of the dioxygen ligand. The effect of various auxiliary ligands on the metal–oxygen vibrations is examined for the Rh complexes, $RhXO_2L_2(RNC)$ (R = tert-Bu, cyclohexyl, p-$CH_3C_6H_4$), and the nature of the metal–oxygen bond is discussed. (auth)

4302 HYDROGEN–DEUTERIUM EXCHANGE OF A CHARGED POLY(METHACRYLAMIDE) AND ITS MONOMERIC ANALOG. Kakuda, Yukio; Perry, Nancy; Mueller, Delbert D. (Kansas State Univ., Manhattan). J. Amer. Chem. Soc.; 93: No. 23, 5992-8 (17 Nov 1971).

The kinetics of hydrogen–deuterium exchange in a charged polymeric amide–poly(ϵ-aminomethacrylyl-L-lysine)—and its monomeric analog, ϵ-aminoisobutyryl-L-lysine, were measured in D_2O solutions. The polymer was selected as a model for charge effects on the exchange rates of proteins since its net charge will vary with pH as that of a protein. Both polymer and monomer showed parabolic rate vs. pD profiles characteristic of specific acid and base catalysis. The polymer, however, had a drastically reduced rate of minimum exchange, K_{min}, compared with the monomer. The polymer also showed a slightly increased pD of minimum exchange, pD_{min}. The shift in pD_{min} was interpreted as a decrease in K_W in the vicinity of the polymer backbone. Although a decrease in K_W also would decrease k_{min}, the major factor contributing to slow exchange appeared to be steric inhibition inherent with each residue. That interpretation is supported by a possible 3-kcal/mol increase in E_a^* for exchange in the polymer over that of the monomer. In addition, internal catalysis by the amino group of the lysine moiety was observed in the polymer. Its effect also showed a drastic reduction over that of small molecules. Interestingly, upon the acquisition of a net positive charge, the rates were reduced, despite evidence for some expansion of the molecule. The rate reductions were about twice those predicted by ΔG_{el} from potentiometric titration data. Possibly, the basicities of carboxylate anions and amide groups are affected differently by the proximity of a positive charge. (auth)

4303 SENSITIVITY OF PARAMETERS EMPLOYED IN SEMIEMPIRICAL TREATMENT OF DISPLACEMENT REACTIONS. A COMPARISON BETWEEN AN ENERGY-DEPENDENT HARD MODEL AND A SOFT MODEL. Baer, Michael; Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel). J. Amer. Chem. Soc.; 93: No. 21, 5343-51(20 Oct 1971).

The recently published energy-dependent hard model for displacement reactions and the soft model due to Karplus and Raff are compared in detail by studying simultaneous trajectories in each of them. The study is performed for different sets of masses and almost over the entire reactive zone (above thermal energies), thus permitting a detailed analysis of the semiempirical parameters used in the two models. (auth)

Physical Chemistry

Refer also to abstracts 5024 and 5169.

4304 (TID-25834) SPECTRAL ABSORPTION COEFFICIENTS OF HELIUM AND NEON BUFFER GASES AND NITRIC OXIDE-OXYGEN SEED GAS MIXTURE. Krascella, N. L. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. 86p. (K-910904-2). Dep. NTIS.

A theoretical investigation was conducted to ascertain the spectral properties of helium and neon as functions of pressure, temperature, and wave number. The spectral properties of these gases have a strong influence on radiative energy transfer in the buffer gas region of nuclear light bulb rocket engines. A computer program was formulated and used to calculate spectral absorption coefficients of helium and neon at total pressures of 50, 100, 250, 500, 750, and 1000 atm in the temperature interval between 1,000 and 30,000°K. At each pressure and temperature, spectral properties were calculated for 47 wave numbers in the interval between 1000 and 1,000,000 cm^{-1}. In addition, previous estimates of spectral characteristics of a nitric oxide-oxygen seed mixture were extended to temperatures below 10,650°R. (auth)

4305 STRUCTURE OF THE α FORM OF URANYL HYDROXIDE. Taylor, J. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Acta Crystallogr., Sect. B; 27: 1088-91(1971).

The crystal structure of α-$UO_2(OH)_2$ was determined from single-crystal x-ray diffraction data. The compound is orthorhombic, space group Cmca or C2cb, with a = 4.242, b = 10.302, and c = 6.868 Å. Least-squares refinement based on the 199 independent observed reflexions in the range $0 < (\sin\theta/\lambda) < 0.81$ in space group Cmca gives a value of $R = \Sigma(|F_o| - |F_c|)/\Sigma|F_o|$ of 0.063. Slight deviations of the oxygen atoms from the levels x = 0 and x = $\frac{1}{2}$, which are allowed in the alternative space group C2cb, were not detectable with these data. Each uranyl group is surrounded by six hydroxyl oxygen atoms in puckered hexagonal configuration. The hexagons are condensed into infinite hexagonal sheets, stacked in layers. There are weak interlayer hydrogen bonds, and probable hydrogen atom positions are deduced. (auth)

4306 VAPOR PRESSURE OF URANIUM(IV) SULPHIDE IN THE TEMPERATURE INTERVAL 2100 TO 2500°K. Nater, K. A. (Reactor Centrum Nederland, Petten, Netherlands). pp 1136-43 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The composition of the vapor over solid uranium monosulfide was determined by mass spectrometry in the temperature interval 2100 to 2500°K. The results are combined with measurements of absolute rate of effusion performed earlier by David Cater. The congruent evaporation of US(s) occurs by two simultaneous reactions US(s) = U(g) + S(g) ΔH^0_T = 281 ± 2 kcal · $mole^{-1}$ and US(s) = US(g) ΔH^0_T = 136 ± 1 kcal · $mole^{-1}$. An estimate of the standard heat of the formation of US(s) was made by application of a third law analysis. The estimated value of $\Delta H^0_{f,298} = -74.2$ kcal · $mole^{-1}$, agrees reasonably well with literature values. (auth)

4307 X-RAY INVESTIGATIONS OF THE PHASE TRANSITION OF THE URANIUM DIPHOSPHIDE UP_2. Pietraszko, Donata; Lukaszewicz, Kazimierz (Inst. for Low Temperature and Structure Research, Wroclaw). Rocz. Chem.; 45: No. 6, 1105-7(1971).

Results of a detailed x-ray investigation show that the dependence of the lattice constants, as well as of the intensities of superstructure reflections, on the temperature prove that at the temperature of 83 ± 3°C uranium diphosphide undergoes a phase transition resulting in the disappearance of the superstructure. The high-temperature form of UP_2 is isostructural with Cu_2Sb with lattice constants of a tetragonal lattice cell with a = 3.812, c = 7.791 at 134°C. (D.H.M.)

4308 VAPOR PRESSURE OF POLONIUM DIOXIDE. Steinmeyer, R. H.; Kershner, C. J. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 33: No. 9, 2847-50 (Sep 1971).

The vapor pressure of PoO_2 was measured by the transpiration technique. In the temperature range 718 to 932°C, the vapor pressure of PoO_2 in an oxygen atmosphere was found to vary according to the relationship $\log P_{(torr)} = -14.27 \pm 0.51 \times 10^3/T + 12.57 \pm 0.46$. The corresponding heat of sublimation (ΔH) at 825°C was calculated as 65.3 ± 2.3 kcal/mole. (auth) (UK)

4309 ENTROPY IN ISOTOPIC SYSTEMS. Hastie, J. W.; Plante, E. R. (National Bureau of Standards, Washington, D. C.). High Temp. Sci.; 3: No. 5, 412-14(Sep 1971).

Many current textbooks and even the research literature appear inadequate in recognizing or discussing certain entropy conventions. The present article elaborates on this question with particular reference to a recent research article that amply demonstrates the errors that can result from the misunderstanding of entropy conventions in isotopic systems. (auth)

4310 SIMPLIFIED EXPERIMENTAL METHOD FOR DETERMINING THE THERMOCHEMICAL PROPERTIES OF CERTAIN VOLATILE SPECIES: APPLICATION TO ReO_2 AND ReO_3. Franklin, J. E.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). High Temp. Sci.; 3: No. 5, 401-11(Sep 1971).

Results are presented in support of a simplified experimental method for determining the free energies and enthalpies of formation of certain volatile species that can be formed by the reaction of a gas with a solid at high temperature and low pressure. The principal feature is the replacement of the conventional Knudsen cell by a solid surface immersed in a gas having sufficiently low pressure so that molecular flow conditions are attained. If the volatile species formed in the gas-solid reaction are assumed to evaporate from the surface in equilibrium proportions, then the free energies of formation of these species may be determined from mass-spectrometric measurements of the vapor composition—just as if the solid surface were a Knudsen cell. It is shown that this assumption is consistent with existing data for WO_2, WO_3, MoO_2, and MoO_3. As an illustration of the application of the method, existing data on the O_2-Re reaction are analyzed to obtain estimates of the free energies and enthalpies of formation of $ReO_2(g)$ and $ReO_3(g)$. On the basis of these results, it is concluded that the present method avoids many of the serious complications associated with Knudsen cells. The limitations of the method are explored. (auth)

4311 TEMPERATURE DEPENDENCE OF CHLORINE NQR FREQUENCIES IN SECOND ROW TRANSITION HEXACHLOROMETALLATES. Fergusson, J. E. (Univ. of Canterbury, Christchurch, New Zealand). Inorg. Nucl. Chem. Lett.; 7: No. 10, 987-91(Oct 1971).

Some data are reported for K_2TcCl_6 and K_2RuCl_6. (UK)

4312 STRUCTURE OF AN 8-COORDINATE ACTINIDE COMPLEX IN SOLUTION. Weidenheft, C. J. (Mound Lab., Miamisburg, Ohio). Inorg. Nucl. Chem. Lett.; 7: No. 10, 1023-8(Oct 1971).

Some NMR studies are reported on the β-isopropyltropolone complexes of U and Th $M(\beta\text{-}C_{10}H_{11}O_2)_4$. In the case of U the NMR spectra showed the expected splitting pattern for coupling with adjacent protons, and the large paramagnetic shifts are due, at least in part, to a pseudocontact shift, which is a dipole-dipole interaction between the anisotropic g-tensors of the paramagnetic metal ion and the resonating nucleus; these paramagnetic shifts should therefore be structure dependent. This structure dependence is discussed, including the procedure for assessing structure. It is concluded that the structure that best fits the NMR data for the U complex in $CHCl_3$ solution is bis-disphenoid, whilst in DMSO (dimethyl sulphoxide) it is the D_4 square antiprism. The results suggest a symmetrical static structure in solution and eliminate excited vibrational states and exchange equivalence as the explanation for ligand equivalence. In $CHCl_3$ the distorted structure apparently allows for increased charge delocalisation on to the ligand, whereas coordination of DMSO forces the complex into a D_4 square antiprism. (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 4611, 5902, and 6052.

4313 (NYO-3570-19) RADIATION CHEMISTRY AND MASS SPECTROMETRY OF SILANE SYSTEMS. Annual Progress Re-

port. Lampe, F. W. (Pennsylvania State Univ., University Park). 1 Jun 1971. Contract AT(30-1)-3570. 36p. Dep. NTIS.

Research progress is reported on the radiation chemistry and mass spectrometry of silane systems that includes construction of tandem quadrupole mass spectrometer; ion–molecule reactions in monosilane at pressure to 0.15 torr; ion–molecule reactions in disilane; ion–molecule reactions in monogermane; and mass spectrometric studies of free radical reactions. (D.H.M.)

4314 (ORO-2968-68) RESEARCH CONCERNING IONIC AND FREE RADICAL REACTIONS IN RADIATION CHEMISTRY. Progress Report, September 15, 1970–September 15, 1971. Williams, T. Ffrancon (Tennessee Univ., Knoxville. Dept. of Chemistry). Contract AT(40-1)-2968. 14p. Dep. NTIS.

Progress is reported on research mainly concerned with the intermediate species in γ-irradiated organic solids at low temperatures. Emphasis is being placed on both structural and kinetic studies using ESR and optical methods of investigation. A number of new paramagnetic species have been discovered, and further evidence has been obtained for hydrogen atom abstraction by quantum tunneling at low temperatures. These results are described. In addition, the long-standing program on the radiation-induced polymerization of liquid monomers is continued and a pulse-radiolysis study of succinonitrile, a plastic crystal, at room temperature is also reported. (auth)

4315 RADIATION EFFECTS AND AFTER-EFFECTS IN THE CLEAR POLYMETHYL METHACRYLATE DOSIMETER. Chadwick, Kenneth Helme. Utrecht; State Univ. of Utrecht (1971). 105p.

Thesis.

The radioinduced optical absorption in clear poly(methyl methacrylate) (PMMA) was studied using OD (optical density) and ESR techniques. The OD-dose relationship was explained on the basis of radical production and destruction and fragment production and destruction for gamma and fast neutron irradiation. The unstable OD component was correlated with the free radical concentration. The photosensitive effect is shown to be caused by a free radical conversion process. The identification of the typical PMMA free radical is considered. (auth)

4316 MASS SPECTROMETRY IN RADIATION CHEMISTRY MEASUREMENTS. Wilson, H. W.; Scott, W. M. (Scottish Research Reactor Centre, Glasgow). pp 466-9 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The mass spectrometry aspects of certain studies carried out at the Scottish Research Reactor Center in the radiation chemistry field are described. (D.H.M.)

Radiation Effects

Refer also to abstract 4373.

4317 RADIATION-CHEMICAL OXIDATION AND NITRATION OF THE ALIPHATIC DILUENT IN TWO-PHASE AQUO-ORGANIC SYSTEMS. Kershulis, V. I.; Egorov, G. F.; Zagorets, P. A. (Inst. of Electrochemistry, Moscow. Moscow Chemicotechnological Inst.). This paper was summarized in Khim. Vys. Energ.; 4: No. 2, 173-3(Mar-Apr 1970). (In Russian).

Full copy of this paper is held by DTIE.

The products of the radiation-chemical oxidation and nitration of the organic components of the extraction system, including the diluent, during the extraction of uranium, plutonium, and other elements by amine salts from active nitric acid solutions often results in a breakdown of the extraction process. The composition and radiation yields were studied of the products from the oxidation and nitration of the diluent of the amine nitrates, for which n-octane containing 30% by weight of n-octyl alcohol was used: 0.2 M solutions of the nitrates of dinonylaniline (DNA), dibenzyldodecylamine (DBDA), and benzyldinonylamine (BDNA) in the diluent and in contact with a 2 M aqueous solution of HNO_3 were irradiated with a beam of fast electrons. The dose strength was $\sim 1.4 \times 10^{18}$ eV/cm^3 · sec. The products were identified and their concentrations were determined by the methods of gas–liquid chromatography (GLC) and infrared spectroscopy (IRS). The oxidation products are formed with functional groups on the 1-, 2-, 3-, and 4th carbon atoms of the octane molecule. Compounds with functional groups on the 1st carbon atom predominate among the nitration products which are formed by the reaction of the octyl alcohol with the nitrous acid which is formed in the decomposition of HNO_3. (auth)

4318 CRYSTALLOGRAPHIC STUDIES OF IRRADIATION/FIELD TREATED TRIGLYCINE SULPHATE: A NEW STRUCTURE FORM. Fletcher, S. R.; Skapski, A. C.; Keve, E. T. (Imperial Coll. of Science and Tech., London). J. Phys., C (London); 4: No. 13, L255-8(17 Sep 1971).

The crystal structure of irradiation-field treated triglycine sulphate was determined by single crystal x-ray methods. The configuration of glycine molecules, relevant to a ferroelectric switching mechanism, showed differences compared to the accepted structure of untreated material. (auth)

4319 BREAKDOWN OF ORGANIC MATERIALS UNDER IRRADIATION. Charlesby, A. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 153-9(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

A brief introductory review is given of the various mechanisms that govern the interaction of organic materials with ionizing radiation. Emphasis is given to the phenomena occurring in organic polymers, their explanation, and the techniques used in the study of these effects. (auth)

4320 EFFECTS OF OPTICAL BLEACHING ON LUMINESCENCE DECAY AND TRAPPED ELECTRON CONCENTRATIONS IN γ-IRRADIATED 3-METHYLPENTANE AT 77°K. Funabashi, K.; Hebert, C.; Magee, J. L. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 75: No. 21, 3221-9(14 Oct 1971). (COO-38-651).

The luminescence decay of γ-irradiated 3-methylpentane (3MP) was studied in the dark and with ir (1600 nm) and uv (265, 325 nm) bleaching for times as long as 8 hr. Bleaching with ir increases the decay rate and bleaching with uv retards it. The emission under all conditions was found to consist of the same two bands: one with a maximum at 380 nm and the other (much smaller) with a maximum at 230 nm. An added hole trap, 2-methyl-1-pentene (2MP-1), was found to increase the decay rate with and without bleaching light and, as in pure 3MP, ir increases the decay rate and uv retards it. The decay rates of trapped electron concentrations were measured in the dark and with ir and uv bleaching. The absorption spectrum was found to be the same under all conditions and for all times studied. For the dark decay the luminescence intensity is proportional to the rate of decrease in trapped electron concentrations; deviations from this proportionality are observed for both ir and uv bleaching and these are partially explained. It seems that there are two kinds of traps for electrons in γ-irradiated 3MP. (auth)

4321 TOWARD A UNIFIED INTERPRETATION OF ESR TRAPPED-HOLE CENTERS IN IRRADIATED BORATE COMPOUNDS AND GLASSES. Taylor, P. C.; Griscom, D. L. (Naval Research Lab., Washington, D. C.). J. Chem. Phys.; 55: No. 7, 3610-11(1 Oct 1971).

The correct spin-Hamiltonian parameters for strontium and lithium diborate compounds after irradiation are reported. It is shown that the spectrum results from a hole on an oxygen bridging between two equivalent 4-coordinated borons, where the symmetry and magnitude of the total hyperfine interaction with two identical borons is virtually the same as that occurring in borates. (M.C.G.)

Radiation Processes

Refer also to abstract 4371.

4322 ADDITION OF PHOSPHORUS TRICHLORIDE TO ISOBUTYLENE UNDER THE INFLUENCE OF γ-RADIATION. Shostenko, A. G.; Zagorets, P. A.; Dodonov, A. M.; Greish, A. A. (Moscow Chemical Engineering Inst.). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 357(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

Chloroisobutyldichlorophosphine (CIDCP) was synthesized by the chain radical addition of PCl_3 to isobutylene initiated by ^{60}Co γ-radiation. Irradiation was carried out in a cell which provided for the bubbling of isobutylene (~5 liter/h). It was first established that G (CIDCP) is independent of the rate of bubbling of the gas when the latter exceeds 4 liter/h. In addition to the 1 : 1 adduct (two isomers) a small quantity of isobutenyldichlorophosphine and alkyl chlorides were also observed. A study of the kinetics of accumulation of CIDCP at various PCl_3: olefin ratios permitted the establishment that the maximum yield of addition product is observed with a fourfold molar excess of PCl_3. The kinetic order of the reaction calculated from the results of investigation of the dependence of G(CIDCP) on the rate of absorbed radiation dose I and equal to 0.54 ± 0.03 indicates quadratic termination of the radical chains. (auth)

4323 DETERMINATION OF THE ABSOLUTE VALUE OF THE RATE CONSTANT OF THE REACTION OF BRANCHING AND THE RATE OF THERMAL GENERATION OF INITIATING

CENTERS FOR A CHAIN REACTION WITH DEGENERATE BRANCHES BY A RADIATION CHEMICAL METHOD. Poluektov, V. A.; Ageev, N. G. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 5, 452-3(Sep-Oct 1970). (In Russian).

Full copy of this paper is held by DTIE.

Tal'roze has indicated that for many compounds the average value of the radiation yield of active particles $G_0 \simeq 3.8$. Knowing this value, by initiating a chain reaction with degenerate branches by ionizing radiation, the rate constant of branching and the rate of generation of the initial centers of the thermal reaction can be determined. These values were found with the liquid phase oxidation of hexachlorobutadiene by gaseous oxygen as an example. The influence of gamma radiation on the rate of oxidation was studied. The basic mechanism of the oxidation of hexachlorobutadiene is the formation of a polymer radical as the primary active intermediate particle, by copolymerization with O_2. The rates of generation of the initial reaction centers according to the known value of the dose rate were calculated. (M.C.G.)

4324 CELLULOSE GRAFT COPOLYMERS. IV. GRAFT COPOLYMERIZATION OF METHACRYLONITRILE WITH γ-IRRADIATED CELLULOSE FROM DMSO-, ACETONE-, AND METHANOL-WATER SYSTEMS. Mares, Trinidad; Hinojosa, Oscar; Nakamura, Yoshio; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 15: No. 10, 2349-56 (Oct 1971).

Methacrylonitrile was graft-copolymerized from DMSO-, acetone-, and methanol-water systems with γ-irradiated, purified cotton cellulose. The relative extents of scavenging of the free radicals in the irradiated cellulose after immersion in the solvents for 3 min at 25°C, as determined by electron spin resonance spectroscopy, were: methanol (77%) > water (70%) ≫ acetone (5%) > DMSO (0%). After immersion of irradiated cellulose in the solvents for 60 min at 25°C, the relative extents of scavenging of the radicals were: methanol, water (80 to 85%) > DMSO (80%) > acetone (62%). From these data, it would appear that the overall rates of diffusion of methanol and water into the fibrous macrostructure were greater than the rates of diffusion of DMSO and acetone into the structure. The relative radiochemical yields of the graft copolymerization reactions of methacrylonitrile with irradiated cellulose in the different solvents were: water ≫ DMSO > methanol ≫ acetone. The addition of water to the systems increased the yields of the reactions. (auth)

4325 ^{60}Co RADIATION-INITIATED OXIDATION OF HYDROCARBONS IN EMULSION. Van Sickle, Dale E.; Hendry, Dale G.; Castleman, Jane K.; Gould, Constance W. (Stanford Research Inst., Menlo Park, Calif.). J. Org. Chem.; 36: No. 22, 3423-9 (5 Nov 1971).

Aqueous emulsions of a variety of hydrocarbons under cobalt-60 irradiation were allowed to react with molecular oxygen at pressures of 1 to 4 atm at 50°. Unlike the effect observed in polymerization, emulsification of styrene had no significant effect on the oxidation rate or products as compared to that observed in hydrocarbon solution. With emulsions of styrene and α-methylstyrene, dependency on the rate of initiation and temperature is consistent with the bulk mechanism, and the product distribution qualitatively parallels bulk oxidations. Other hydrocarbons investigated include cyclohexene, cyclopentene, tetramethylethylene, tetralin, and cumene. The efficiency of initiation by radiation varied from 10 to 40%. (auth)

4326 STARCH GRAFT POLYMERS. I. GRAFT CO- AND TERPOLYMERS OF STARCH WITH 2-HYDROXY-3-METHACRYLOYLOXYPROPYLTRIMETHYLAMMONIUM CHLORIDE AND ACRYLAMIDE: PREPARATION AND EVALUATION AS SILICA DEPRESSANTS. Jones, Duane A.; Jordan, Wesley A. (General Mills Chemicals, Inc., Minneapolis). J. Appl. Polym. Sci.; 15: No. 10, 2461-9(Oct 1971).

The title monomers were grafted onto wheat starch by γ-radio-induced polymerizations in water providing three graft polymers containing poly(2-hydroxy-3-methacryloyloxypropyltrimethylammonium chloride) (I) and two graft polymers containing poly(I) and acrylamide (II). Characterization is discussed together with their utility as silica depressants in flotation-beneficiation of siliceous ores. Results are provided to illustrate that a starch graft copolymer containing 15% poly(I) graft and a graft terpolymer containing 30% poly(I, II) in the ratio 1:2 are effective as selective depressants for silica in flotation-beneficiation of Florida pebble phosphate ore using special flotation conditions. (auth)

Radiolysis

Refer also to abstracts 5622, 5636, and 5637.

4327 (AAEC/LIB/Bib-315) PULSE RADIOLYSIS OF STYRENE. A Bibliography. Newland, E. A. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1971. 7p. Dep. NTIS (U. S. Sales Only).

Sixty-two references covering the period 1957 to 1971 are listed. They are arranged alphabetically by author within each year, and, where applicable, abstracts to articles are cited. (Australia)

4328 (FRNC-TH-96) γ RADIOLYSIS OF METHANOL AND WATER-METHANOL MIXTURES. Mitterrand, Bernard (Bordeaux Univ. (France)). 1971. 70p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Free ion yields produced by the gamma irradiation of methanol and binary water-methanol mixtures were studied and the results were compared with those of the Freeman theory. The aldehyde is formed through a fast mechanism involving the successive liberation of two hydrogen atoms from the same alcohol molecule. Glycol probably comes from the dimerization of hydroxymethyl radicals, a slow reaction taking place inside the solution. The yields of solvated electrons measured are in good agreement with previous results. The variation of these yields with the static dielectric constant of the medium shows that the double recombination phenomenon takes place before the dielectric relaxation of the medium. (France)

4329 FREE RADICALS IN γ-IRRADIATED MONO(2-ETHYLHEXYL)PHOSPHORIC AND DI(2-ETHYLHEXYL)PHOSPHORIC ACIDS AND TRI-n-BUTYL PHOSPHATE. Arkhipov, V. P.; Votinov, M. P.; Romanovskii, V. N.; Semushin, A. M. (Leningrad Polytechnical Inst.). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 362(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

Free radicals stabilized in frozen (77°K) mono(2-ethylhexyl) phosphoric (M2EHPA) and di(2-ethylhexyl)phosphoric acids (D2EHPA) and tri-n-butyl phosphate (TBP) were investigated under the influence of ^{60}Co γ-rays. Examination of the electronic structure and analysis of the EPR spectra led to the assumption that in M2EHPA and D2EHPA the free radicals are primarily stabilized with localization of the unpaired electron on the tertiary carbon atom. Thawing of irradiated M2EHPA, D2EHPA, and TBP is accompanied by rapid reactions with the participation of free radicals and by their complete disappearance at room temperature. (auth)

4330 SPECTROSCOPIC EVIDENCE FOR THE FORMATION OF THE MERCUROUS ION IN IRRADIATED ACETATES. Eachus, R. S.; Herring, F. G. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 49: No. 17, 2868-73(1 Sep 1971).

The Hg(I) center was produced by γ irradiation both in Hg(II)-doped cadmium acetate trihydrate and pure mercuric acetate. Both electron paramagnetic resonance and optical spectroscopy were used to identify this species. The results indicate that the Hg(I) ion is produced in a covalent environment. (auth) (Canada)

4331 RADIATION CATALYTIC SYNTHESIS OF ETHYLENEDIAMINE AND OXALIC ACID ON ZEOLITES. Breslav, Yu. A.; Kotov, A. G.; Pshezhetskii, S. Tu. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 348-9(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

Experimental data on the low-temperature radiolysis of methylamine and formic acid adsorbed on zeolites are presented. When formic acid adsorbed on NaA zeolites is γ irradiated at 77°K, COOH and HCO radicals, which were identified by their EPR spectra, are formed. The recombination of the COOH radicals, which takes place when the samples are heated, results in the formation of oxalic acid. The oxalic acid yield is equal to approximately half of the yield of the COOH radicals. It follows from this that practically all the COOH radicals recombine forming oxalic acid. The CH_2NH_2 and apparently the $CH_2 = NH^+$ radicals are the low-temperature radiolysis products of methylamine adsorbed on NaA zeolite. The recombination products of these radicals, ethylenediamine and ammonia, are formed when the samples are heated. The molecular products were determined chromatographically. It was established that the recombination of the CH_2NH_2 radicals results in the formation of the corresponding amount of ethylenediamine. The radiation-catalytic synthesis of ethylenediamine and oxalic acid is distinguished by its high selectivity compared with the radiolysis of the original sorbates, methylamine, and formic acid, in a homogeneous phase. (auth)

4332 THEORY OF RADIOLYSIS IN A PERIODIC SOURCE FIELD. Chernenko, A. A.; Brodskii, A. M. (Inst. of Electrochemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 347-8(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

A study is reported that considers the behavior of short-lived radiolysis products at mean concentrations over a complete time interval. Kinetic equations were obtained using nonlinear mechanics for the mean concentration of all substances participating in the reactions. (D.H.M.)

4333 RADICAL FORMATION IN THE RADIOLYSIS OF SOLID bis-β-HYDROXYALKYL SULFIDES. Trofimov, V. I.; Chkheidze, I. I.; Malievskii, A. D. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 360(Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

EPR has been used to study the nature of the radicals formed in the low-temperature radiolysis of bifunctional compounds of two β-hydroxyalkyl sulfides, viz., β-hydroxytethylthiol and bis-β-hydroxyethyl sulfide. Analysis of the spectrum of irradiated bis-β-hydroxyethyl sulfide showed that at −196°C $R_1\dot{S}CHCH_2OH$ radicals (~15 to 20%) and, quite probably RO oxy-radicals are stabilized in the sample. On warming to −130°C only the signal of RO radicals is observed in the sample. With a further increase in the temperature of the sample this signal disappears and the lines of the asymmetrical spectrum of the "alkyl sulfide" $R_1S^{\cdot}$ radicals. The changes in the EPR spectra take place in the temperature ranges of certain phase transitions which were observed by radioluminescence. Similar conversions of the primary radicals into the secondary $R_1S^{\cdot}$ radicals are also observed in irradiated β-hydroxyethylthiol. When bis-β-hydroxypropyl sulfide is irradiated $R_2S\dot{C}HCH(CH_3)OH$, $R_2SCH_2 \cdot \dot{C}(CH_3)OH$, and RO' radicals, which have different thermal stability, would appear to be formed. It should be noted that in this case the lines of the "alkyl sulfide" RS radicals are not generally observed, in contrast to the first two compounds. Thus, in none of the three bifunctional compounds studied at −196°C do the molecules dissociate along the C−S or S−H bonds, whereas it is known that in, for example, thiols, disulfides, and sulfones these processes are among the principal processes. (auth)

4334 γ-RADIOLYSIS AND LOW-TEMPERATURE PHOTOLYSIS OF MALEIMIDES. Arkhipov, V. P.; Votinov, M. P.; Ivanov, V. S. (Leningrad Polytechnical Inst.). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 363 (Jul−Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

The EPR absorption with similar-in-character triplet spectra in γ- and uv-irradiated maleimide (MI), N-phenylmaleimide (N-PMI), N-(p-toly)maleimide (N-p-TMI), N-(p-chlorophenyl) maleimide (N-p-CPMI), N-benzylmaleimide (N-BMI), and N-(2,4-dimethylphenyl)maleimide (N-2 4-DMPMI) was recorded. The structure of the EPR spectra is independent of the energy of the irradiation quanta and the radiation dose. It is assumed that the improved resolution of the individual components of the spectra during photolysis is explained by the lower local concentration of paramagnetic centers (PMC) formed in comparison with radiolysis. The relative concentration of PMC is lower by a factor of 2-5 in N-substituted maleimides in comparison with MI. The nature of the phenyl substituents does not substantially change the nature of the radiation transformations but increases the reactivity of the PMC generated by irradiation. (auth)

4335 TEMPERATURE DEPENDENCE OF DISPROPORTIONATION-COMBINATION RATIOS FOR ALKYL RADICALS IN LIQUID METHANE. Gillis, Hugh A. (National Research Council of Canada, Ottawa. Carnegie-Mellon Univ., Pittsburgh). Can. J. Chem.; 49: No. 17, 2861-7(1 Sep 1971). (NRCC-12117).

The ratios of rate constants for disproportionation to combination were measured for ethyl radicals and for isopropyl radicals in liquid methane between −181 and −94°C. The radicals were generated by γ radiolysis of dilute methane solutions of ethylene-d_4 or propylene-d_6. The activation energy for combination was found to exceed that for disproportionation by 290 ± 30 cal $mole^{-1}$ for ethyl radicals and by 255 ± 25 cal $mole^{-1}$ for isopropyl radicals. In both cases the disproportionation−combination ratio in the liquid, extrapolated to room temperature, is greater than that in the gas phase by a factor of about 2.5. These results are interpreted as indicating that disproportionation and combination reactions proceed by way of different transition states. (auth) (Canada)

4336 PHOTOCHEMISTRY OF FREE RADICALS. RADICALS OF ALCOHOLS AND ETHERS. Chervonenko, V. S.; Roginskii, V. A.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 5, 450-1(Sep-Oct 1970). (In Russian).

Full copy of this paper is held by DTIE.

The photoconversions of radicals formed in the γ-irradiation of methanol, ethanol, propanol, isopropanol, butanol, as well as diethyl, dipropyl, and diisopropyl ethers, were investigated by the EPR method, low-temperature spectroscopy, and chromatography. After γ-irradiation, in all cases radicals are formed with stripping of a hydrogen atom in the α-position with respect to the OH or OR groups. Various photoconversion reactions are discussed. (M.C.G.)

4337 VAPOR PHASE RADIOLYSIS OF ISOPROPANOL AND WATER-ISOPROPANOL MIXTURES. II. NITROUS OXIDE AS ELECTRON SCAVENGER. Bailey, M. G.; Dixon, R. S. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem.; 49: No. 17, 2909-12(1 Sep 1971). (AECL-3897).

Nitrous oxide reduces the hydrogen yield from water−isopropanol vapor mixtures by complete scavenging of electrons. Nitrogen is produced over the whole concentration range but the yield at higher isopropanol concentrations is much greater than the electron yield. The results indicate a competition between water and isopropanol for a secondary species resulting from electron attachment to N_2O. Reaction of this species with isopropanol leads to further N_2 whereas reaction with water does not. The reactive intermediate is most probably N_2O^- or $N_2O_2^-$. (auth) (Canada)

4338 INTERACTIONS IN THE SILICON–SILICON(IV) CHLORIDE AND SILICON–SILICON(IV) CHLORIDE–HYDROGEN SYSTEMS. Meshcheryakov, N. A. (Inst. of Mathematics, Novosibirsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 470-3(Apr 1971).

Reactions occurring in the Si − $SiCl_4$ and Si − $SiCl_4$ − H_2 systems were examined. The formation of radicals and the kinetics of the reactions at 293 to 900°K were investigated by means of the electron spin resonance spectra. The spectra indicate participation by the radicals SiCl, $SiCl_2$, and $SiCl_3$, and also $SiCl_4^+$, which is formed on exposure of the initial $SiCl_4$ preparation in the solid state to ^{60}Co γ quanta. (auth)

4339 REACTIONS OF ORGANIC RADICALS FORMED BY SOME FENTON-LIKE REAGENTS. Czapski, Gideon (Carnegie-Mellon Univ., Pittsburgh); Samuni, A.; Meisel, D. J. Phys. Chem.; 75: No. 21, 3271-80(14 Oct 1971).

The reactions of Fe^{2+}, Cr^{2+}, V^{4+}, and Ti^{3+} with H_2O_2 in the presence of 2-propanol were studied using the ESR flow technique. It was shown that all these "Fenton-like" reagents form OH radicals which can react with the 2-propanol. From studies of the ESR intensities of the alcohol radical as a function of H_2O_2, Ti^{3+}, and that of added Ti^{4+}, Fe^{3+}, and Cr^{3+} it is concluded that these ions react faster with $(CH_3)COH$ than with $CH_2CHOHCH_3$. The reaction of the alcohol radicals with H_2O_2 was also studied by radiolysis experiments. The unusual kinetics and properties of "Fenton-like reagent" and OH and R radicals generated by these reagents previously reported is shown to be due to wrong kinetic assumptions. (auth)

4340 GROWTH PATTERNS OF REACTION INTERMEDIATES PRODUCED BY SELF-RADIOLYSIS OF TRITIATED ETHYL IODIDE AT 77°K. Ogren, Paul J.; Willard, John E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 75: No. 21, 3359-67(14 Oct 1971).

The trapped intermediates produced by the self-radiolysis of tritiated glassy and polycrystalline ethyl iodide at 77°K were investigated with the aid of their ESR and optical spectra. The initial growth rates are proportional to the specific activity but decrease with time at rates which are different for the different species. In glassy ethyl iodide, ethyl radicals grow to plateau concentrations which are proportional to less than the first power of the specific activity, the kinetics indicating that the radicals are removed by a process stimulated by the radiation, or that competing processes interfere with their production as the concentration of reaction intermediates increases. The average radical lifetime in the steady state at 101°K, the highest temperature at which radicals could be observed in competition with thermal decay, is ca. 15 sec. Between 77 and 95°K the radical decay rates increase with an Arrhenius factor of 2.5 kcal $mole^{-1}$, but increase much more rapidly above 95°K. Illumination of γ-irradiated samples in the 400 to 500-nm range removes trapped C_2H_5 radicals. Tritiated glassy samples emit a steady-state luminescence with an intensity approximately proportional to the specific activity. The synthesis of C_2H_4TI from T_2, C_2H_4, and I_2 is described. (auth)

4341 SITES OF ATTACK OF HYDROXYL RADICALS ON AMIDES IN AQUEOUS SOLUTION. II. THE EFFECTS OF BRANCHING alpha TO CARBONYL AND TO NITROGEN. Hayon, E.; Ibata, T.; Lichtin, N. N.; Simic, M. (Army Natick Labs., Mass. Boston Univ.). J. Amer. Chem. Soc.; 93: No. 21, 5388-94(20 Oct 1971).

The reaction in aqueous solution of OH radicals with a number of amides was studied by the technique of pulse radiolysis-kinetic absorption spectroscopy. Compounds investigated include

$CH_3CONHC(CH_3)_3$, $CH_3CON(CH_3)C(CH_3)_2$, $CH_3CON(C_2H_5)_2$, $CH_3CH_2CONH_2$, $CH_3CH_2CONHCH_3$, $(CH_3)_2CHCONH_2$, $(CH_3)_2CHCONHCH_3$, $(CH_3)_2CHCON(CH_3)_2$, $(CH_3)_3CCCONH_2$, $(CH_3)_3CCONHCH_3$, $(CH_3)_3CCONHC(CH_3)_3$, $(CH_3)_3CCON(CH_3)_2$, $(CH_3)_3CCON(C_2H_5)_2$, and $C_6H_5CONH_2$. The chloroamides $CH_3CHClCONH_2$, $CH_2ClCH_2CONH_2$, and $CH_2ClCONHC(CH_3)_3$ were allowed to react with hydrated electrons to generate specific radicals by displacement of chloride. The generality of the spectral features of radicals of the type $R'CON(R'')C<$ in the wavelength range 230 to 600 nm was verified These include a peak with λ_{max} in the region 235 to 248 nm and ϵ_{max} in the range 7000 to 9000 $M^{-1}cm^{-1}$, and another with λ_{max} at 340 to 390 nm and ϵ_{max} 1600 to 2600 $M^{-1}cm^{-1}$. The absorption spectra of radicals produced by abstraction of an α hydrogen consist of single peaks with $\epsilon_{max} \sim 1000\ M^{-1}cm^{-1}$ and λ_{max} at >340 nm, and are shifted bathochromically by N-alkylation and hypsochromically by α-alkylation. Radicals produced by abstraction of hydrogen from methyl groups which are β to either carbonyl or amido nitrogen absorb at short wavelengths, with $\lambda_{max} < 230$ nm. Combination of spectral data with rate constant values of κ(OH + amide) provides values of specific rates of attack at different sites. It is seen that for these reactions, the rates of which are only one or two orders of magnitude below the diffusion-controlled limit, reactivity varies systematically with molecular environment; e.g., α-methylation increases and N-alkylation decreases the rate of abstraction of α hydrogen. Isolation of $CH_3CON(CH_3)CH_2CH_2N(CH_3)COCH_3$ from reaction of aqueous $CH_3CON(CH_3)_2$ with OH generated by steady radiolysis confirmed previous assignment of the principal site of attack on this molecule. (auth)

4342 PHOTOLYSIS OF AZIDE DISSOLVED IN ALKALI HALIDES. Testa, J. F.; Robinson, D. W. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 55: No. 6, 3056-7(15 Sep 1971).

Azides in alkali metal host solvents were subjected to uv and x irradiation. Decomposition and ir and EPR spectra were studied. (M.C.G.)

4343 ESR STUDY OF RADICALS FORMED BY IRRADIATION OF K_2PtCl_4 SINGLE CRYSTALS. Krigas, Thomas; Rogers, Max T. (Michigan State Univ., East Lansing). J. Chem. Phys.; 55: No. 6, 3035-44(15 Sep 1971).

Single crystals of K_2PtCl_4 irradiated at 77°K show two groups of ESR lines, one belonging to a radical giving rise to hyperfine interaction with two equivalent platinum nuclei and the second from a radical giving hyperfine interaction with one platinum and three chlorine nuclei. On the basis of the observed g, $A(^{195}Pt)$, and $A(^{35,37}Cl)$ tensors, it is suggested that these species are $[(PtCl_4)_2]^{3-}$ and $[PtCl_3]^{2-}$, respectively, with d^{10} and d^9 configurations. On warming to 125°K part of the dimeric radical is converted to a new species whose ESR parameters are consistent with the structure $[PtCl_3]^{2+}$ with a d^7 configuration. The structures of these radicals are discussed. (auth)

4344 MODEL FOR NEUTRALIZATION AND SCAVENGING OF CHARGES IN IRRADIATED DIELECTRIC LIQUIDS. II. ELECTRON SCAVENGING UNDER gamma RADIOLYSIS. Mozumder, A. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 6, 3026-34(15 Sep 1971).

Yield of a scavenging reaction in competition with charge neutralization was calculated in the diffusion model for the isolated ion-pair case and also for multiple ion-pair cases. Following an earlier lead by Hummel, this yield is shown as a Laplace transform of the survival probability against neutralization in absence of scavenger. The Laplace transform itself is evaluated numerically using earlier work for the isolated ion-pair case and the results of the accompanying paper for the multiple ion-pair cases. Experimental results of Schuler et al. for electron scavenging in γ radiolysis of cyclohexane solutions are compared with the present calculations for the isolated ion pair and also for the entire track. For the latter a probability function for energy deposition derived from our previous work has been used. It was concluded that the square-root law at low scavenger concentrations is a general result of the classical diffusion theory, independent of the size and shape of the entity being scavenged and indeed independent of the mode of generation of charges. This law is, in fact, not limited to charge scavenging only. A discussion is made of other related experiments, such as of mobility (Schmidt and Allen) and of time dependence of negative-ion yield (Thomas), and it is concluded that a single set of diffusion and rate constants can consistently explain all the experimental results. (auth)

4345 MODEL FOR NEUTRALIZATION AND SCAVENGING OF CHARGES IN IRRADIATED DIELECTRIC LIQUIDS. I. EVOLUTION OF THE NEUTRALIZATION PROCESS IN MULTIPLE ION-PAIR CASES. Mozumder, A. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 6, 3020-5(15 Sep 1971).

A diffusion model was constructed for calculating the survival probability, as a function of time, against neutralization in multiple ion-pair cases in irradiated dielectric liquids. Such situations are generated by the absorption of a substantial amount of energy in a relatively small region. The geometry of the region is taken as spherical for energy deposit <500 eV and as cylindrical if energy deposit is ≥500 eV. The infinite-time limit of the so-calculated survival probability gives the probability of escaping charge neutralization which is calculated and compared with two experiments. The agreement is satisfactory. The mutual electrostatic interaction between the charges is considered through a screened field within the framework of prescribed diffusion. The relevant Smoluchowski equation is then integrated in time to give the desired survival probability. Special considerations, as described in the text, are necessary at long time limits. The results are compared between the two geometries used here and also with earlier work on isolated ion pair. (auth)

4346 ELECTRON SPIN RESONANCE SPECTRA OF RSO_2 RADICALS FORMED BY THE X RADIOLYSIS OF SULFONES. Geoffroy, M.; Lucken, E. A. C. (Univ., Geneva). J. Chem. Phys.; 55: No. 6, 2719-23(15 Sep 1971).

X irradiation of single crystals of dibenzyl sulfone yielded the $PhCH_2S^{\cdot}O_2$ radical while irradiation of $PhSO_2CH_2COOH$, $PhSO_2CH_3$, and $PhSO_2Ph$ yielded the $PhS^{\cdot}O_2$ radical. The principal values of the g and ^{33}S hyperfine coupling tensors were measured ($PhCH_2S^{\cdot}O_2$: g = 2.0027, 2.0056, 2.0094; A_{33S} = 96.3, 63.4, 56.2 G; $PhS^{\cdot}O_2$: g = 2.0023, 2.0051, 2.0072; A_{33S} = 107.1, 71.3, 71.3 G) and are discussed in terms of the electronic structure of these species. In $PhSO_2CH_2COOH$ a further radical, g = 1.89, 1.98, 2.04, is observed at low temperatures and is probably a trapped electron. (auth)

4347 PARAMAGNETIC RELAXATION STUDY OF SPATIAL DISTRIBUTION OF TRAPPED ELECTRONS IN GAMMA-IRRADIATED ORGANIC GLASSES. Lin, D. P.; Kevan, Larry (Wayne State Univ., Detroit). J. Chem. Phys.; 55: No. 6, 2629-35(15 Sep 1971).

Paramagnetic relaxation characteristics of trapped electrons in γ-irradiated glassy 3-methylpentane (3-MP) at 71°K, and triethylamine (TEA) and methyltetrahydrofuran (MTHF) at 77°K were studied by power saturation techniques. For MTHF and TEA the characteristic relaxation time, $(T_1T_2)^{\frac{1}{2}}$, is constant with radiation dose at low doses and decreases at higher doses. For 3-MP the relaxation time decreases even at low dose. Together with data on the total spin concentration the results are interpreted in terms of a "spur" model in which the radiation-produced trapped electrons and radicals are trapped in clusters at low dose and constitute a nonuniform spatial distribution. According to this model the spur radius is >130 Å in 3 MP, 101 Å in TEA, and 63 Å in MTHF. These radii compare with 58 Å for trapped electrons in glassy methanol and 41 Å in glassy alkaline ice (10M NAOH). For all of these matrices the radius within which the electrons are trapped appears to increase with decreasing polarity of the matrix, and consequently radiation-produced electrons appear to travel farther before being trapped in less polar matrices. (auth)

4348 GAMMA RADIOLYSIS OF DIMETHYL SULFOXIDE STUDIED BY SPECTROPHOTOMETRIC AND GAS CHROMATOGRAPHIC ANALYSIS. Machado, J. C.; Ronneau, C.; Cara, J.; Apers, D. J.; Capron, P. C. (Univ., Louvain, Belg.). Radiochem. Radioanal. Lett.; 8: No. 1, 33-5(25 Sep 1971).

Dimethyl sulfoxide(DMSO) was tested for its possible application in dosimeters for doses ranging from 0.25 to 2.5 Mrad. (auth)

4349 FREE RADICALS IN IRRADIATED IMIDAZOLES. Boehme, U. R. (Univ., Stuttgart). J. Chem. Phys.; 55: No. 7, 3614-15(1 Oct 1971).

The ESR spectrum of x-irradiated imidazole shows a characteristic splitting of about 45G and three lines with an intensity ratio of 1:2:1. It was concluded that the splitting is caused by the CH_2 protons of a radical formed by hydrogen addition to carbon 2. (M.C.G.)

4350 SEARCH FOR A TRAPPED HOLE IN AN IRRADIATED CRYSTAL OF L-ALANINE BY THE ESR TECHNIQUE. Friday, Estelle A.; Miyagawa, Ichiro (Univ. of Alabama, Tuscaloosa). J. Chem. Phys.; 55: No. 7, 3589-94(1 Oct 1971).

Crystals of L-alanine, $CH_3CHNH_3^+CO_2^-$, and also $CH_3CHND_3^+CO_2^-$, $CH_3CDNH_3^+CO_2^-$, and $CH_3CDND_3^+CO_2^-$ were irradiated at 80°K, and their ESR absorptions were observed at the same temperature. Most of the observations were made at 9 GHz, although some observations were made at 24 and 35 GHz. In addition to the known absorption from the trapped electron (or anion), an absorption with many peaks was detected and was attributed to the trapped hole (or cation) of L-alanine. From the hfs tensor for one of the methyl protons and other evidence, the electron hole was found to be

trapped predominately at the C–C bond connecting the methyl group to the α-carbon atom. In the four crystals examined, the concentration of the cation was comparable to that of the anion. (auth)

4351 ESR STUDY OF A CARBOXYL RADICAL TRAPPED IN A SINGLE CRYSTAL OF MALEIC ACID IRRADIATED AT 77°K. Eda, Bunzo; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys.; 55: No. 7, 3442-9(1 Oct 1971).

The ESR evidence for the carboxyl radical, the existence of which is often assumed in organic solution chemistry as a reaction intermediate, was obtained in a single crystal of maleic acid-d_2 (DOOC–CH=CH–COOD) irradiated at 77°K in the dark. The radical was found to be formed by the removal of the deuteron attached to the side oxygen atom. The g tensor was determined to be (2.0261, 2.0061, 2.0035). The unpaired electron of the radical occupies the in-plane p orbitals of the carboxyl oxygen atoms, forming a σ electron radical. The carboxyl radical is believed to be produced from the positive primary by transferring the acidic proton to the neighboring molecule. The carboxyl radical fragments into a vinyl-type radical. These results indicate that R· radicals often found in irradiated carboxylic acids (RCOOH) originate from the positive primary via the carboxyl radical (RCOO·). (auth)

4352 INTERMEDIATES PRODUCED FROM THE ONE-ELECTRON OXIDATION AND REDUCTION OF HYDROXYLAMINES. ACID-BASE PROPERTIES OF THE AMINO, HYDROXYAMINO, AND METHOXYAMINO RADICALS. Simic, M.; Hayon, E. (Army Natick Labs., Mass.). J. Amer. Chem. Soc.; 93: No. 23, 5982-6(17 Nov 1971).

The optical absorption spectra of the intermediates produced from the one-electron oxidation and reduction of hydroxylamines were observed using the technique of pulse radiolysis. The hydroxyl radicals produced from the radiolysis of water were found to react much faster with the unprotonated hydroxylamines as compared to the protonated form: $k(OH + N^+H_3OH) \leq 5.0 \times 10^8$ M^{-1} sec^{-1}, $k(OH + NH_2OH) = 9.5 \times 10^9$ M^{-1} sec^{-1}. The intermediate produced has an absorption maximum at 217 nm, ϵ_{217} 2.5×10^3 M^{-1} cm^{-1}, and decays by second-order kinetics, $2k = 4.5 \pm 2.0 \times 10^8$ M^{-1} sec^{-1}. This spectrum is assigned to the hydroxylamino radical ·NHOH. From an examination of its acid-base properties, a $pK(\cdot N^+H_2OH \rightleftharpoons \cdot NHOH + H^+) = 4.2 \pm 0.1$ was obtained. A similar examination of the one-electron oxidation of O-methylhydroxylamine shows λ_{max} 218 nm, ϵ_{218} 1.4×10^3 M^{-1} cm^{-1}, $2k = 1.4 \times 10^9$ M^{-1} cm^{-1}, and $pK(\cdot N^+H_2OCH_3 \rightleftharpoons \cdot NHOCH_3 + H^+) = 2.9 \pm 0.2$. One-electron reduction of hydroxylamine by hydrated electrons showed a dependence on the state of protonation of the molecule: $k(e^-_{aq} + N^+H_3OH) = 1.2 \times 10^{10}$ M^{-1} sec^{-1} and $k(e^-_{aq} + NH_2OH) = 9.2 \times 10^8$ M^{-1} sec^{-1}. The intermediate produced is the ammonium radical cation, $e^-_{aq} + N^+H_3OH \rightarrow \cdot NH_3^+ + OH^-$, and its adduct to benzene to give the $NH_2C_6H_6$ radical has λ_{max} 310 nm and ϵ_{310} 7400 M^{-1} cm^{-1}. A similar reaction takes place with O-methylhydroxylamine. From its pH dependence on reaction with thiocyanate ions, the dissociation constant of the ammonium radical cation was obtained, $pK(\cdot NH_3^+ \rightleftharpoons \cdot NH_2 + H^+) = 6.7 \pm 0.2$. The properties of this radical are discussed. (auth)

4353 ASCORBIC ACID FREE RADICALS. I. PULSE RADIOLYSIS STUDY OF OPTICAL ABSORPTION AND KINETIC PROPERTIES. Bielski, Benon H. J.; Comstock, David A.; Bowen, Richard A. (Brookhaven National Lab., Upton, N. Y.). J. Amer. Chem. Soc.; 93: No. 22, 5624-9(3 Nov 1971).

Absorption spectra of L-ascorbic acid free radicals generated in aqueous solutions (pH −0.3 to 11) by pulse radiolysis were determined. Variation in extinction coefficients with pH suggests that the radicals can exist in a protonated form ($AH_2^+\cdot$), as a neutral species (AH·), and as anion radicals ($A^-\cdot$), with pK values of 1.10 and 4.25. The radicals decayed by second-order kinetics throughout the entire pH range. A mechanism is proposed which accounts for the observed acid-catalyzed decay. Ionic strength effects at various pH's are consistent with charges assigned to the various radical species. (auth)

Radioisotope Production

Refer also to abstract 4400.

4354 (FRNC-TH-69) CHEMICAL BEHAVIOR OF ^{37}S PRODUCED BY THE REACTION $^{37}Cl(n,p)$ IN ALKALI-METAL CHLORIDES. Meyer, Jean-Paul (Strasbourg Univ. (France). Faculte des Sciences). 1970. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Data concerning the nuclear reaction $^{37}Cl(n,p)^{37}S$ and the experimental methods used are presented. The results obtained from the solid-state irradiation of alkali metal chlorides are exposed. The chemical states of S in aqueous solution are investigated and the results obtained in the irradiation of LiCl in methanol are presented. The distribution of the different degrees of oxidation of S produced in the reaction $^{36}S(n,\gamma)^{37}S$ is examined. (France)

4355 PREPARATION OF CARRIER-FREE RADIONUCLIDES FROM CYCLOTRON TARGETS BY CONTINUOUS ELECTROPHORESIS. II. SEPARATION OF $^{111,112m}In$ FROM CADMIUM, ^{113m}Cd, AND $^{113,117m}Sn$ FROM INDIUM, ^{206}Bi FROM LEAD, AND ^{210}Po FROM BISMUTH TARGETS. Proso, Z.; Pucar, Z. (Inst. Ruder Boskovic, Zagreb). J. Radioanal. Chem.; 3: No. 3-4, 187-94(Sep 1969).

Continuous electrophoretic separations of the components of cadmium, indium, lead, and bismuth cyclotron targets after bombardment with deuterons are described. The rates of separation were: cadmium target, 0.85 mg Cd/h and 1.2 mg Cd/h; indium target, 2.4 mg In/h; lead target, 1.33 mg Pb/h; bismuth target, 2.5 mg Bi/h. The results are presented by radioautographs and in diagrams showing the distribution of the target material and radioactivity along the lower edge of the filter paper sheets. The radiochemical purity of the separated radionuclides was checked by means of gamma spectrometry, by estimation of β and α energies and by evaluation of the decay curves. The radionuclides were obtained in carrier-free form and in high radiochemical purity. (auth)

4356 RAPID SEPARATION OF ^{95}Nb FROM ^{95}Zr BY SOLVENT EXTRACTION WITH α-BENZOINOXIME. Yoshida, H.; Yonezawa, C. (Japan Atomic Energy Research Inst., Tokai) J. Radioanal. Chem.; 5: No. 2, 201-6(July 1970).

A solvent extraction method is presented for the separation of ^{95}Nb from ^{95}Zr. ^{95}Nb is extracted quantitatively into a chloroform solution of α-benzoinoxime from 5N hydrochloric acid solution. By following the recommended procedure, a saparation factor higher than 10^4 is achieved. ^{95}Nb can be back-extracted into concentrated hydrochloric acid. The radiochemical purity of the ^{95}Nb separated was ascertained by half-life and γ energy measurements. The whole procedure takes less than 20 min. (auth)

4357 PREPARATION OF CARRIER-FREE ^{102}Rh AND ^{102m}Rh. Francois, J. P.; Gijbels, R.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 5: No. 2, 251-64(Jul 1970).

Long-lived rhodium radionuclides were produced by the following reactions: $^{103}Rh(n,2n)^{102(m)}Rh$; $^{103}Rh(\gamma,xn)^{100}Rh$, $^{102(m)}Rh$; $^{104}Pd(d,\alpha)^{102(m)}Rh$; $Ru(d,n)^{99}Rh$, $^{101(m)}Rh$, $^{102(m)}Rh$; and $^{104}Ru(n,\gamma)$ $^{105}Ru \xrightarrow{\beta^-} {}^{105}Rh$. The average cross section of the $^{103}Rh(n,2n)^{102}Rh$ reaction in a fission neutron spectrum is about 0.75 mb. Irradiation of rhodium in the bremsstrahlung spectrum of 50-MeV electrons yielded a ^{102}Rh activity of 0.11 μCi/g after 3 days at a power of 2 kW. The thick target yield of the reaction $^{104}Pd(d,\alpha)^{102}Rh$ was 0.002 μCi/μAh for 12-MeV deuterons. The thick target yield of the reaction $Ru(d,xn)^{102}Rh$ was 0.05 μCi/μAh for 12-MeV deuterons and 4.8 μCi/Ah for 18-MeV deuterons. The best yield was obtained by deuteron bombardment of ruthenium. The chemical separation of carrier-free Rh radionuclides from deuteron-irradiated ruthenium is described, with a chemical yield better than 90%. The same procedure was also applied for the isolation of ^{105}Rh from neutron-irradiated ruthenium. Gamma spectra of ^{99}Rh, $^{101(m)}Rh$, and $^{102(m)}Rh$ from deuteron-irradiated ruthenium and of ^{105}Rh from neutron-irradiated ruthenium, taken with a Ge(Li) detector, are shown; a number of γ rays, not reported in the literature, were observed. The γ energies were determined with a precision of ca. 0.3 to 0.4 keV. (auth)

4358 SEPARATION OF HIGH-ACTIVITY ^{196}Au FROM THE PLATINUM MATRIX, SILVER, COPPER, AND ZINC. Neirinckx, R. D.; van der Merwe, M. J. (South African Council for Scientific and Industrial Research, Pretoria). Radiochem. Radioanal. Lett.; 8: No. 1, 41-5(25 Sep 1971).

An anion exchange procedure for separation of gold activities from a platinum matrix contaminated by silver, copper, zinc, and cadmium was devised for routine production of carrier-free quantities of ^{196}Au. The purity of the final product is satisfactory and, as most operations can be easily performed behind a lead shield, the radiation hazard is reduced considerably. (auth)

4359 ^{99m}Tc AND ^{113m}In GENERATORS USING CHROMIUM PHOSPHATE. Fuessy, E.; Szirtes, L. (Isotope Inst., Budapest). Radiochem. Radioanal. Lett.; 8: No. 1, 19-23 (25 Sep 1971).

The use of chromium phosphate in ^{99m}Tc and ^{113m}In generators was investigated. ^{99m}Tc and ^{113m}In can be eluted with a radionuclidic purity of 98 and 92%, respectively. (auth)

4360 PRODUCTION OF LEAD-FREE ^{207}Bi. Neirinckx, R. D. (South African Council for Scientific and Industrial

Research, Pretoria). Radiochem. Radioanal. Lett.; 8: No. 1, 59-64(25 Sep 1971).

An extraction procedure for the separation of ^{207}Bi from a lead matrix was devised. ^{203}Pb-tracer experiments revealed that one extraction and two washings with 0.2M HNO_3 are sufficient for the ^{207}Bi purification. For the determination of the ^{207}Bi half-life by means of a mass separator, the organic phase must be washed five times with 0.2M HNO_3, leaving a lead content lower than the nanogram level in the ^{207}Bi fraction, which is satisfactory for mass separator requirements. (auth)

4361 PREPARATION AND BEHAVIOUR OF SOME CHEMICAL FORMS OF RADIOIODINE IN AQUEOUS SOLUTIONS. I. PREPARATION OF CARRIER-FREE RADIOIODATE. Palagyi, S.; Zaduban, M.; Brutovsky, M. (Safarik Univ., Kosice, Czech.). Radiochem. Radioanal. Lett.; 8: No. 2, 79-88(14 Oct 1971).

The preparation of carrier-free radioiodate by oxidation of radioiodide with NaClO or Chloramine B is described. The oxidation process was investigated quantitatively, using various amounts of the oxidants at various pH values, reaction times, and temperatures. A chemical yield of ca. 100% was obtained with Chloramine B at pH 3 and room temperature, after 5 min. (auth)

4362 PREPARATION AND BEHAVIOUR OF SOME CHEMICAL FORMS OF RADIOIODINE IN AQUEOUS SOLUTIONS. II. PREPARATION OF CARRIER-FREE RADIOPERIODATE. Palagyi, S.; Zaduban, M. (Safarik Univ., Kosice, Czech.). Radiochem. Radioanal. Lett.; 8: No. 2, 89-96(14 Oct 1971).

The preparation of carrier-free radioperiodate by oxidation of radioiodide with Chloramine B and NaClO is described. Radioiodide is oxidized quantitatively to radioperiodate in 30 min at about pH 13, using NaClO at 100°C. (auth)

4363 RADIOCHEMICAL SEPARATION OF RHENIUM(VII) FROM TUNGSTEN(VI). Klofutar, C.; Krasovec, F.; Kodre, A. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). J. Radioanal. Chem.; 5: No. 1, 3-10(May 1970).

The absorption of rhenium(VII) and tungsten(VI) ions on Al_2O_3 from HCl, $HClO_4$, HNO_3, H_2SO_4, H_3PO_4, NaOH, NH_4OH, NaCl, NaF, and Na tartarate solutions by batch equilibration, as well as by passage through a chromatographic column, was studied. The results show that rhenium(VII) can be effectively separated from tungsten(VI) using any of the acid or salt solutions investigated. The experimental data allowed a simple procedure to be developed for the radiochemical separation of rhenium isotopes from an irradiated WO_3 sample. (auth)

Recoil Production and Reactions

4364 (COO-1713-21) SILICON ATOMS: RECOIL CHEMISTRY. Gaspar, Peter P.; Markusch, Peter; Choo, Kwang Yul; Holten III, J. Dewey (Washington Univ., St. Louis, Mo. Dept. of Chemistry). [nd]. Contract AT(11-1)-1713. 32p. (CONF-710332-1). Dep. NTIS.

From Nuclear award symposium; Los Angeles, Calif. (30 Mar 1971).

Some new information about recoil silicon chemistry is presented and some facets of an emerging picture of the reaction mechanisms are suggested. (D.H.M.)

4365 REACTION OF TRITIUM RECOIL ATOMS WITH SEVERAL ALANINE DERIVATIVES. Simonov, E. F. (Moscow State Univ.). This paper was summarized in Khim. Vys. Energ.; 4: No. 2, 171(Mar-Apr 1970). (In Russian).

Full copy of this paper is held by DTIE.

The interaction of tritium recoil atoms with complexes of copper and phthalyl derivatives of α- and β-alanine was studied. Mixtures of the amino acids (or their derivatives) with lithium carbonate were irradiated 1 h in a 1.2×10^{13} neutron/cm^2 · sec stream of slow neutrons. The analysis of the irradiated samples was accomplished by gas-liquid and paper chromatography. It may be concluded from the resulting data that spatial factors and the capability of the mother compound to dissipate excess energy affect primary tritium recoil atom interaction with amino acids in the crystalline state. (auth)

4366 SZILARD-CHALMERS REACTIONS IN DICYCLOPENTADIENYLDIIRONTETRACARBONYL. Kanellakopulos-Drossopulos, W.; Wiles, D. R. (Kernforschungszentrum, Karlsruhe, Ger.). Can. J. Chem.; 49: No. 18, 2977-82(15 Sep 1971).

In neutron-irradiated solid $[CpFe(CO)_2]_2$ radioactive $FeCp_2$ and $Fe(CO)_5$ are formed, in addition to the radioactive parent compound. The radiochemical yields before annealing are 1.4, 3.2, and 16.0%, respectively. The predominance of $Fe(CO)_5$ over $FeCp_2$ is in keeping with previous observations. The yield of radioferrocene is not affected by subsequent thermal treatment at up to 75°C, while the yields of the two carbonyl-containing compounds are increased up to 5.4 and 20.1%. The ferrocene yield is insensitive to irradiation time and temperature. From this insensitivity it is concluded that the Fe-Cp bonds are reformed by epithermal processes. Similarly the Fe-CO bonds are reformed by thermal as well as epithermal reactions. (auth) (Canada)

4367 RECOIL REACTION PRODUCTS OF ^{11}C IN C_5 HYDROCARBONS. Jewett, G. L.; Voigt, A. F. (Ames Lab., Iowa). J. Phys. Chem.; 75: No. 21, 3201-4(14 Oct 1971).

Gaseous and liquid radioactive products up to C_6 compounds produced by the $^{12}C(\gamma,n)^{11}C$ reaction in liquid n-pentane, isopentane, 1-pentene, cyclopentane, and cyclopentene were separated and analyzed by radio gas chromatography. Results were interpreted in terms of insertion reactions by the carbon atom and methylene radical, and the relative probabilities of fragmentation and stabilization reactions following their insertion in the parent molecules were determined. (auth)

4368 CHEMISTRY OF NUCLEAR RECOIL ^{18}F ATOMS. IV. HOT F-TO-HF AND F-TO-F_2 ABSTRACTION IN CH_2CF_3. Parks, Norris J.; Krohn, Kenneth A.; Root, John W. (Univ. of California, Davis). J. Chem. Phys.; 55: No. 6, 2690-8 (15 Sep 1971).

New hot abstraction reaction channels were demonstrated for nuclear recoil ^{18}F atoms reacting with fluorocarbon substrates. Hot F-to-HF abstraction in CH_3CF_3 is a very efficient process with an absolute hot yield of 51% ± 3%. Hot F-to-F_2 reactions also occur, but with much lower efficiencies. The F-to-F_2 hot yields in CH_3CF_3, C_2F_6, and C_3F_8 are 5.4% ± 0.3%, 6.9% ± 0.8%, and 11.7% ± 0.5%, respectively. In good agreement with theoretical expectations, translational excitation appears to be much more effective as a driving force for the exoergic F-to-HF process in comparison with the endoergic F-to-F_2 process. The Arrhenius activation energy for thermal F-to-HF abstraction in CH_3CF_3 is at least 2.1 ± 0.1 kcal/mole larger than the value associated with the thermal ^{18}F-atom pi-addition process in C_3F_6. (auth)

4369 SURVIVAL PROBABILITY OF PRODUCTS OF HOT REACTIONS OF (n,γ)-PRODUCED ^{38}Cl WITH CH_3Cl IN THE GAS PHASE. Alfassi, Z. B.; Baer, M.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Chem. Phys.; 55: No. 7, 3094-3100(1 Oct 1971).

The hot reactions of (n,γ)-produced ^{38}Cl with CH_3Cl were studied in the presence of three noble gas moderators: He, Ar, and Kr, using Br_2 as a scavenger. The main purpose of this work was to study the extent of decomposition of the newly formed products on collision with Ar and Kr. Applying the method of Baer and Amiel, it was established that the average survival probability of the various hot products in Ar and Kr is 100%, within the experimental error. Kinetic parameters for the three hot products, $CH_3{}^{38}Cl$, $CH_2Cl^{38}Cl$, and $CH_2{}^{38}ClBr$ were determined as well. (auth)

Radiochemistry

Refer also to abstracts 4200, 4206, 4222.

4370 (FRNC-TH-91) STUDY OF THE DEGREE OF OXIDATION OF ^{233}Pa FORMED IN THE β DECAY OF ^{233}Th IN THORIUM HALIDES IRRADIATED IN A NUCLEAR REACTOR. Carlier, Roger (Conservatoire National des Arts et Metiers, Paris (France)). [nd]. 78p. (In French). Dep. NTIS (U. S. Sales Only).

The initial degree of oxidation of ^{233}Pa was defined; the distribution of this element in the 4^+ and 5^+ degrees of oxidation, resulting from the $^{232}Th(n,\gamma)\,^{233}Th \rightarrow {}^{233}Pa$ reaction, was studied. It was shown that the $^{233}Th \rightarrow {}^{233}Pa$ transformation in Th tetrahalides irradiated for very short periods in a reactor, leads only to pentavalent ^{233}Pa. Secondary phenomena are important. The percentage of ^{233}Pa(IV) increases with the pH of the dissolution and the ^{233}Pa(IV)/^{233}Pa(V) ratio in the solid depends upon the amount of radiation absorbed. The radiolysis of the matrices of Th tetrahalide involves a reduction of ^{233}Pa(V) followed by a progressive accumulation of the molecular halogen of radiolytic origin. A reoxidation of ^{233}Pa(IV) into ^{233}Pa(V) is observed. (France)

4371 (SRARI-P-71) KINETICS OF RADIATION-CHEMICAL REDUCTION OF AMERICIUM(VI) AND AMERICIUM(V) IN AN AQUEOUS SOLUTION IN THE PRESENCE OF PEROXIDISULFATE IONS. Ermakov, V. A.; Timofeev, G. A.; Rykov, A. G.; Yakovlev, G. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 20p. (In Russian). INIS.

The radiation-chemical reduction of americium(VI) and americium(V) was measured spectrophotometrically in 0.1 to 0.2 M HNO_3 solutions containing $S_2O_8^{2-}$ ions and at various dose levels

of internal alpha radiation. A change in concentration of $S_2O_8^{2-}$ did affect the reduction rate of Am(V) but very slightly affected the reduction rate of Am(VI). Both rates were a function of the alpha radiation dose; fixed concentrations of the radicals H^+ and OH^- were linear functions of the magnitude of the dose. A mechanism of the reactions is suggested based on the radiolysis theory of water, with satisfactory agreement with experimental data. (tr-auth)

4372 GAMMA-RAY ENERGIES OF RADIONUCLIDES FORMED BY URANIUM FISSION AND PHOTON ACTIVATION. Adams, F.; Dams, R. (Ghent Univ.). J. Radioanal. Chem.; 3: No. 3-4, 271-85(Sep 1969).

4373 DEHYDRATION OF CRYSTALLINE HYDRATES OF RADIOACTIVE MAGNESIUM AND SODIUM SULFATES. Spitsyn, Vikt. I.; Mikhailenko, I. E.; Voronin, Yu. V. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 3, 645-8(21 May 1971). (In Russian).

In a study of conversion processes in solid substances crystalline preparations of nonradioactive $MgSO_4 \cdot 7H_2O$ and $Na_2SO_4 \cdot 10 H_2O$ were grown from saturated aqueous solutions. Similar hydrates containing radioactive sulfur were grown under identical conditions. At a heating rate of 6°/min the heat of dehydration of the radioactive $Na_2SO_4 \cdot 10 H_2O$ (100 mCi of ^{35}S per gram) was lowered by 10 to 12% below that of the nonradioactive material. In the case of the $MgSO_4 \cdot 7H_2O$, the nonradioactive compared with two radioactive samples (51 and 102 mCi, respectively) also showed that the thermal effect of the reaction is decreased by the presence of radioactivity: the higher the level of radioactivity the greater the difference between the heats of conversion of the nonradioactive and radioactive samples. (K.S.W.)

4374 CHEMICAL CONSEQUENCES OF THE CONVERTED ISOMERIC TRANSITION OF ^{129m}Te IN SOME INORGANIC TELLURIUM COMPOUNDS. Lebedev, R. A.; Babeshkin, A. M.; Nesmeyanov, A. N.; Tsikanov, V. A.; Fatieva, N. L. (Moscow State Univ.). Radiochem. Radioanal. Lett.; 8: No. 1, 65-73 (25 Sep 1971).

The chemical consequences of the isomeric transition of ^{129m}Te were investigated on ^{129}I nuclei by means of emission gamma resonance spectroscopy. The chemical states of the daughter atoms of ^{129}Te and the relative yields of these states were determined. The data were compared with the results of other investigations carried out by both radiochemical and nuclear gamma resonance methods. The electron configuration of the valence shell of ^{129}I, responsible for the nonparental stabilization form of ^{129}Te was calculated. (auth)

4375 ^{80m}Br/I.T./^{80}Br REACTIONS IN INORGANIC BROMIDE–HYDROCARBON SYSTEMS. II. VARIATION OF THE ORGANIC YIELD WITH THE SOLVENT. Mohan, M.; Iyer, R. M. (Bhabha Atomic Research Centre, Trombay, India). Radiochem. Radioanal. Lett.; 8: No. 1, 1-5(25 Sep 1971).

If ^{80m}Br present as $SrBr_2$ undergoes an isomeric transition reaction in aliphatic and aromatic hydrocarbons, significant diffferences in organic yields are observed. Studies in mixtures of aliphatic hydrocarbons and benzene showed drastic reduction of organic yields indicating the protective action of benzene. The results were interpreted as due to positive charge stabilization by the aromatic ring. (auth)

Separation Processes

Refer also to abstracts 4165, 4356, 4358, 4465, 6293.

4376 (70-CNA-623) BRUCE HEAVY WATER PLANT. Progress Report, [May 1970]. Robson, R. D. (Lummus Co. Canada Ltd., Don Mills (Ontario)). 9p. (CONF-700564-17). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

The plant consists of two enriching units, a finishing unit, and various service and supply facilities required for their operation. The products of the two enriching units are combined to feed an 800-ton per year finishing unit, which is designed to take a 30% D_2O feed. This unit upgrades the D_2O to 99.8% by vacuum distillation. Construction status is discussed. (M.C.G.)

4377 (BMBW-FBK-71-7) TECHNICAL PRODUCTION OF ^{230}Th. Kluge, E.; Lieser, K. H. (Technische Hochschule, Darmstadt (West Germany). Eduard-Zintl-Institut). Aug 1971. 56p. (In German). Dep. NTIS (U. S. Sales Only).

Thorium-230 (Ionium) may be used for the production of ^{232}U. The possibilities of the ionium recovery from the effluents of the uranium mill in Ellweiler (Germany) by different methods are investigated. The ionium is coprecipitated with iron hydroxide, the hydroxides are dissolved in nitric acid, and the ionium is extracted into TBP–kerosene. After reextraction, thorium is precipitated as hydroxide first, then as oxalate, and then refined. The yield is >90%. The amount of chemicals and a list of apparatus necessary for the recovery of ionium are given. (auth)

4378 (CEA-R-4126) STUDY OF THE PHOTOCHEMICAL OXIDATION OF MERCURY. APPLICATION TO THE SEPARATION OF THE ISOTOPES OF MERCURY. Morand, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 77p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

The effect of 2537 Å radiation on the mixtures $Hg-O_2$ and $Hg-O_2-C_4H_6$ were studied experimentally by determining the quantum yield of the oxidation of mercury. The results obtained demonstrate the existence of an excited complex of the type HgO_2^* that is responsible for the isotopic oxidation in the case of selective excitation of the mercury isotopes. The photo-decomposition of mercuric oxide was demonstrated. The experimental results were used to perfect an apparatus which photochemically separates the isotopes of mercury. The theoretical study of the complex HgO_2^* indicates that it has a linear structure in the $^3\Pi$ electronic state. This complex is thermodynamically more stable than the mixture $Hg(^3P_1) + O_2(^3\Sigma_g^-)$ and has an ionic character (charge transfer complex). (auth)

4379 (DOCKET-406622-2) SHIRLEY BASIN URANIUM MILL. Environmental Report, Operating License Stage, Supplement. (Utah International, Inc., San Francisco, Calif.). 9 Nov 1971. 270p. Dep. NTIS.

Location of the mine, mill, and townsite are discussed along with the environmental impact of the proposed action, alternatives to specific aspects of the operation that would avoid these effects, adverse environmental effects from continued operation, relation between local short-term uses of man's environment and maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitment of resources involved in the proposed action. (M.C.G.)

4380 (DOCKET-50201-92) WEST VALLEY REPROCESSING PLANT. Quarterly Report, July 1–September 30, 1971, Part I. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 29 Oct 1971. 8p. Dep. NTIS.

Results are reported on environmental monitoring, low-level liquid effluents, stack effluents, and surveillance tests. (M.C.G.)

4381 (DOCKET-50201-93) WEST VALLEY REPROCESSING PLANT. Environmental Report No. 10, January–June 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Aug 1971. 27p. Dep. NTIS.

During the first half of 1971, 800 separate analyses were made on samples of air, water, milk, fish, and silt. The increase in airborne activity in the second quarter was due to springtime transfer of radioactivity from the stratosphere to the troposphere. Various radioactivity concentrations are given. (M.C.G.)

4382 (HEDL-TME-71-123) STATUS OF ELECTROLYTIC DISSOLUTION FOR LMFBR FUELS. Cooley, C. R. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 52p. Dep. NTIS.

Electrolytic dissolution technology was reviewed and found sufficiently developed to reprocess LMFBR fuels. Capacity is limited by design configuration, heat generation, and current density. New designs of multibarrel electrolytic dissolvers were estimated to process 0.5 to 1 MT/day of LMFBR fuel depending on the amount of stainless steel cladding processed with the fuel. Although estimates of the capital costs for new electrolytic dissolvers are reasonable, the incremental cost for installation of additional plant capacity for waste systems to handle additional liquid waste from the process is excessive as compared to current shearing and acid leaching. (auth)

4383 (IEA-209) SORPTION OF URANIUM IN URANYL NITRATE SOLUTIONS ON STRONG CATIONIC RESINS AND ITS ELUTION WITH AMMONIUM SULFATE. I. SELECTIVE FIXATION OF THORIUM. Ribas, Antonio G. S.; Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). May 1970. 26p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The uranyl ion sorption on strong cationic resin and its elution with ammonium sulfate was done to complement some work being performed in the uranium purification field. The behavior of thorium present as main impurity was studied as a function of flow rate, uranium concentration, and acidity of the uranyl nitrate

solution. Uranium and thorium were eluted selectively with ammonium sulfate. (auth)

4384 (JUL-777-CT) USE OF CHEMICAL CELLS IN THE JUELICH NUCLEAR FACILITY FOR REPROCESSING IRRADIATED HTGR FUEL ELEMENTS. Riedel, H. J.; Utecht, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Jul 1971. 12p. (In German). (CONF-710618-3). Dep. NTIS (U. S. Sales Only).

From thirteenth Euratom hot laboratory meeting; Juelich, Germany (24 Jun 1971).

At the Juelich Nuclear Center, a building is under construction that is called chemistry cells. Operation is scheduled to start in early 1972. Essentially, burned up HTGR fuel elements will be reprocessed. Design of the building and various components are presented. Described are reprocessing, waste solidification, and isolation of various isotopes. (H.B.G.)

4385 (NP-19070) DEVELOPMENTAL WORK ON EXTRACTION OF URANIUM. Progress Report, June 1971. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 56p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The developmental work on extraction of uranium from slates in central Sweden is presented. The results of the operation period 1966 to 1969 are described together with results and valuations of the technical developmental work to the summer of 1971. The techniques and design of a large scale plant for extracting uranium are described. Costs are estimated. (KK) (Sweden)

4386 (WaBoLu-2/70) SUITABILITY AND RELIABILITY OF RADIOACTIVE WASTE WATER PROCESSING PLANTS. Aurand, K.; Arndt, J.; Wolter, R. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene). Jul 1970. 21p. (In German). INIS.

The plants installed in the FBG for the removal of radioactive waste water at users in research, medicine, and industry (not including nuclear research centers, nuclear power plants) were tested for suitability and reliability also with regard to eventual simplification and improvement. Based on a written questioning, the experiences at the individual users were evaluated. Moreover numerous local visitations were made. Based on the evaluation, on the experience gained during visitation, and exhaustive theoretical considerations, general recommendations for the removal of radioactive waste waters were elaborated. (INIS)

4387 CHROMATOGRAPHIC SEPARATION OF NIOBIUM, MOLYBDENUM, AND TUNGSTEN ON ALUMINUM OXIDE. Kharlamov, I. P.; Krivenkova, N. P.; Byrko, V. M. (Moscow State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1824-8(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1428-33(Dec 1970).

Aluminum oxide was used in the separation of niobium and tungsten and to remove small quantities of tungsten from large quantities of molybdenum. Metal ions are absorbed on aluminum oxide in the OH form and separated from other ions. Tracer studies indicated that it is possible to achieve quantitative results in the separations. (J.G.B.)

4388 SEPARATION OF FISSION PRODUCTS BY EXTRACTION CHROMATOGRAPHY. I. DETERMINATION OF DISTRIBUTION COEFFICIENTS. Denig, R.; Trautmann, N.; Herrmann, G. (Univ., Mainz). J. Radioanal. Chem.; 5: No. 2, 223-31(Jul 1970). (In German).

The possibilities for the separation of a complex fission product mixture by extraction chromatography were investigated. Here the partition coefficients between three solvents and hydrochloric acid are reported for the following elements: Zn(II), Ge(IV), As(III), As(V), Se(IV), Zr(IV), Nb(V), Mo(VI), Tc(IV), Ru(III), Ru(IV), Rh(III), Ag(I), Cd(II), In(III), Sn(IV), Sb(III), Sb(V), Te(IV), I(oxidized), Cs(I), Ce(III), Tb(III), Tm(III), Ac(III), Th(IV), Pa(V), U(VI), Np(IV), Np(VI). As solvents tri-n-butyl phosphate (TBP), tri-n-octylamine (TOA), and bis-(2-ethylhexyl) orthophosphate (HDEHP) were used. The partition coefficients were measured by batch experiments in which the solvents were adsorbed on polytrifluoromonochloroethylene powder. (auth)

4389 SOLVENT EXTRACTION OF Hf(IV) AND Zr(IV) WITH SOME 1-PHENYL-3-METHYL-4-ACYLPYRAZOLONES-5. Navratil, O.; Jensen, B. S. (Danish Atomic Energy Research Establishment Riso, Roskilde). J. Radioanal. Chem.; 5: No. 2, 313-22(Jul 1970).

The distribution of Hf, Zr, and Nb between aqueous solutions of mineral acids and solutions of 1-phenyl-3-methyl-4-acylpyrazolones-5 (acyl = acetyl, ethoxycarbonyl, butyryl, capronyl, capryl, and benzoyl) in various organic solvents was studied. The dependence of the distribution ratio of metal on the acidity of the aqueous phase, the analytical concentrations of reagents and metals, and on the organic solvent was investigated. The composition of the complex extracted is MeP_4 for Hf and Zr. The conditions for the separation of Zr, Hf, and Nb are defined, and a comparison is made with extractions by means of thenoyltrifluoroacetone. (auth)

4390 URANIUM AMALGAM FROM AQUEOUS SOLUTION. II. Malan, H. P.; Kobayashi, Y.; Ishimori, T. (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 9, 3097-3105(Sep 1971).

Various factors that influence the extractability of uranium from aqueous uranyl solution with sodium amalgam were investigated. Conditions for the virtually complete extraction of uranium from aqueous solution are described. Uranium amalgam containing more than 50 mg U/ml Hg was obtained in one extraction. (auth)

4391 CHROMATOGRAPHIC SEPARATION OF VANADIUM, TUNGSTEN, AND MOLYBDENUM WITH A LIQUID ANION-EXCHANGER. Fritz, James C.; Topping, Joseph J. (Ames Lab., Iowa). Talanta; 18: No. 9, 865-72(Sep 1971).

In acidic solution only molybdenum(VI), tungsten(VI), vanadium(V), niobium(V), and tantalum(V) form stable, anionic complexes with dilute hydrogen peroxide. This fact was used in developing an analytical method of separating molybdenum(VI), tungsten(VI), and vanadium(V) from other metal ions and from each other. Preliminary investigations using reversed-phase paper chromatography and solvent extraction led to a reversed-phase column chromatographic separation technique. These metal-peroxy anions are retained by a column containing a liquid anion-exchanger (General Mills Aliquat 336) in a solid support. Then molybdenum(VI), tungsten(VI), and vanadium(V) are selectively eluted with aqueous solutions containing dilute hydrogen peroxide and varying concentrations of sulphuric acid. (auth)

4392 STUDY OF ION DIFFUSION IN ION EXCHANGE RESINS BY AN AUTORADIOGRAPHIC METHOD. Madi, I.; Varro, T. (L. Kossuth Univ., Debrecen, Hungary). Nature (London) Phys. Sci.; 233: No. 36, 10(6 Sep 1971).

A new autoradiographic method is described for following ion diffusion in the resin phase, and was used in the study of the diffusion of $^{212}Pb^{2+}$, $^{144}Ce^{3+}$, and $^{137}Cs^{+}$ in swollen Amberlite IRC-50(H) bead resin. Values obtained for the grain diffusion constant ($\bar{D}$) for the foregoing three ions were 4.16×10^{-8}, 1.83×10^{-8}, and 8.3×10^{-7} $cm^{-2}s^{-1}$, respectively. (UK)

4393 EXTRACTION OF RARE METALS BY PHOSPHINE OXIDES. Kuznetsova, Yu. S.; Laskorin, B. N.; Suvorovskaya, N. A. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 91-4 (1971). (In Russian).

The water-phosphine oxide distribution of neodymium was studied in relation to the following factors: pH of the aqueous phase, Nd concentration, salting-out agents, and nature of the organic radicals in the phosphine oxide. Kerosene solutions of the following compounds were tested: $(C_6H_5)(C_{7-9}H_{15-19})_2PO$, $(i\text{-}C_5H_{11})(i\text{-}C_8H_{17})_2PO$, $(i\text{-}C_5H_{11})(C_{7-9}H_{15-19})_2PO$, and $(i\text{-}C_8H_{17})(C_{7-9}H_{15-19})_2PO$. Rare earth extraction from solutions containing Ca and Fe ions is discussed. (K.S.W.)

4394 HYDROLYSIS OF CAPRINOHYDROXAMIC ACID. Obukhova, M. E.; Voden, V. G.; Pushlenkov, M. F. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 875-6(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 900-1(Nov-Dec 1970).

Hydroxamic acids are used for the extraction of trivalent and tetravalent actinides and lanthanides from acid solution, however, their use is hindered by their hydrolysis under the action of strong mineral acids, which are catalysts for the hydrolysis reaction. A study was made of the hydrolysis of caprinohydroxamic acid (CHA) in the organic phase. On the basis of the data obtained on the rate of hydrolysis of CHA in octanol under the action of nitric acid it was concluded that CHA is sufficiently stable if the nitric acid concentration in the organic phase is 0.01 to 0.001 M and consequently, CHA can be used as the extraction reagent for metals from aqueous nitric acid medium under the condition that the nitric acid concentration in the aqueous solution does not exceed 0.1 M. (D.H.M.)

4395 SEPARATION OF URANIUM, PLUTONIUM, AND FISSION PRODUCTS ON INORGANIC ION-EXCHANGERS. Naqvi, S. J. (Pakistan Atomic Energy Commission, Karachi). Nucleus (Karachi); 8: No. 1-2, 76-83(Jan-Jun 1971).

Experimental results on the final purification of plutonium from $^{95}Zr(+^{95}Nb)$ and ^{106}Ru, using inorganic ion exchangers are presented. (auth)

4396 ENRICHMENT OF LITHIUM ISOTOPES BY ION EXCHANGE. Hagiwara, Z.; Takakura, Y. (Tohoku Univ., Sendai). pp 383-9 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The separation factors for the $^{6}Li-^{7}Li$ pairs were measured in the various ion-exchange systems involving lithium salts and strongly acidic cation-exchange resins such as Dowex 50W, and Diaion SK or PK with different crosslinkages (X 12-20). These measurements were performed by a breakthrough technique in column operation, and the excellent results were obtained in the exchange systems with lithium acetate and a porous type of Diaion PK 240-X20, or a gel type of Diaion SK 116-X16. Further, in order to investigate some variables related to the efficiency of isotope separation, the ion-exchange enrichment of lithium isotopes has been carried out by displacement chromatography using a new exchange system, where both ^{7}Li and ^{6}Li were remarkably enriched at the leading and tail edges of the lithium sorption band. The ion-exchange reactions concerning the present systems were discussed. In addition, the present enrichment systems were analyzed on the basis of the induced relationships relating to the rate theory in the ion-exchange process. (auth)

4397 ISOTOPE SEPARATION BY ION EXCHANGE AND ISOTOPE RATIO ANALYSIS BY GAMMA SPECTROMETER. Aaltonen, J. (Univ. of Helsinki). pp 390-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The separation of the isotopes ^{24}Mg, ^{25}Mg, and ^{26}Mg, ^{56}Co and ^{60}Co, ^{88}Y and ^{91}Y, and ^{144}Sm, ^{147}Sm, ^{148}Sm, ^{149}Sm, ^{150}Sm, ^{152}Sm, and ^{154}Sm by ion exchange was studied. Isotope ratio analyses of the fractions of Mg and Sm runs were done by mass spectrometry and those of Co and Y runs by γ spectrometry. (D.H.M.)

4398 URANIUM ISOTOPE SEPARATION BY CHEMICAL EXCHANGE. Shimokawa, J.; Nishio, G.; Kobayashi, F. (Japan Atomic Energy Research Inst., Tokai). pp 397-402 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The isotope separation effect between U(IV) complex and U(VI) ions was investigated in a mixed system of uranyl solution and cation exchange resin containing uranous ions. (auth)

4399 TIME DEPENDENCE OF THE SPONTANEOUS DEPOSITION OF ^{210}Po ON A SILVER FILM STUDIED BY A NEW APPARATUS COUPLED TO A Si(Au) DETECTOR. Hashimoto, T. (Kyoto Univ.). Radiochem. Radioanal. Lett.; 8: No. 1, 25-31(25 Sep 1971).

The spontaneous deposition of ^{210}Po on a thin silver film, vacuum-evaporated onto a polyester film, was studied with a new apparatus coupled to a Si(Au) surface barrier detector. The deposition of ^{210}Po on the silver film was continuously monitored by recording the spectrum of the α particles passing through the film during the activity measurements. The plot of the total activity against the deposition time is linear. (auth)

4400 CARRIER-FREE SEPARATION OF THORIUM FROM URANIUM. Buksak, D.; Chow, A. (Univ. of Manitoba, Winnipeg). Radiochem. Radioanal. Lett.; 8: No. 1, 7-9(25 Sep 1971).

Carrier-free ^{231}Th may be separated cleanly from ^{235}U by holding the U on a purified anion exchange column and eluting Th with 12M HCl. (auth)

4401 EXTRACTION OF SEVERAL ELEMENTS WITH TRIOCTYLMONOMETHYLAMMONIUM CHLORIDE. Ueno, Kaoru; Saito, Akira (Japan Atomic Energy Research Inst., Tokai). Anal. Chim. Acta; 56: No. 3, 427-34(Oct 1971).

Radiochemical studies of the solvent extraction behavior of twenty-five elements in the ammonium carbonate or ammonium sulfate–trioctylmonomethylammonium chloride–toluene systems were performed. The distribution ratios were determined in 0.1 to 2.0 M ammonium carbonate solutions and in 0.1 to 3.0 M ammonium sulfate solutions. The K_d value for each element generally depends on the inverse power of the carbonate concentration in the aqueous phase, while the K_d value is essentially unaffected by the sulfate concentration in the aqueous phase. Separation methods for ^{237}U from fission products with these extraction systems are presented (auth)

4402 MULTI-LOADED METAL SALTS(S)-ION EXCHANGE RESINS. THEIR PREPARATION AND APPLICATIONS. Watari, Kazuo; Imai, Kiyoko; Izawa, Masami (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri; 6: No. 1, 9-13(Mar 1971).

The possibility of incorporating one or more kinds of insoluble metal salts in one ion exchange resin matrix by utilizing the residual ion exchange capacity of the resins was explored. The products were named multi-loaded metal salt(s)-ion exchange resins. Multi-loaded metal salt(s)-ion exchange resins can be classified into two categories: (a) multi-loaded single metal salt-ion exchange resin, which contains only one metal salt in an ion exchange resin, and (b) multi-loaded composite metal salts-ion exchange resin, which contains two or more different metal salts in a resin. It was found that the adsorption ability for cesium of multi-loaded nickel ferrocyanide-Amberlite IRA-904 increased linearly with the number of multiload treatment, and that simultaneous adsorption of cesium and strontium was possible by using nickel ferrocyanide-calcium phosphate-Amberlite IRA-904. The preparation of the resins and their application in the fields of radiochemistry and health physics are discussed. Structure of the resins was also studied. (auth) (Japan)

4403 RAPID CARRIER-FREE SEPARATION METHOD FOR DIVALENT RARE EARTHS. Lawless, F. R.; Wahlgren, M. A. (Argonne National Lab., Ill.). J. Radioanal. Chem.; 5: No. 1, 11-20(May 1970).

A separation of carrier-free divalent rare earths by electrolytic reduction and amalgamation is described. The separation is carried out in a water-jacketed cell, 1 cm diameter by 10 cm long, fitted with a stopcock at the bottom. The cell utilizes a Pt anode and Hg cathode. The electrolyte used is potassium citrate–rare earth acetate at a concentration of 10 mg rare earth oxide per ml. The decontamination factor observed for Lu in a typical separation for Yb is $\geq 10^4$. Sm, Eu, and Yb are all amalgamated if present in the sample. For the present study, the parameters were evaluated primarily for the case of Yb. A current of 100 mA is applied to 0.5 ml of electrolyte containing 1 to 1000 μg of Yb(III) for 5 min. The amalgam is decomposed and the Yb recovered by shaking for 1 min with 6M HCl. The overall time required is about 10 min and the yield is reproducible at 84 to 85%. Under these conditions, the electrolyte may contain up to 3.5 mg of Yb although at 2 mg the yield begins to decrease. The effects of current time, density, and electrolyte concentration are discussed. This method has the advantage of being rapid and carrier-free, and the separated rare earth is in a form suitable for further chemical separation if required. (auth)

4404 SEPARATION AND DECONTAMINATION OF URANIUM FROM NITRIC ACID FISSION PRODUCT SOLUTIONS WITH ANION EXCHANGERS. Stoeppler, M. (Kernforschungsanlage, Juelich, Ger.). J. Radioanal. Chem.; 5: No. 1, 21-30(May 1970). (In German).

Weight distribution coefficients for U(VI) against Dowex 1 and Dowex 2 in HCl–HNO_3 and practical column-exchange capacities under defined conditions were determined. The behavior of thorium, protactinium, iron, zirconium, niobium, ruthenium, and tellurium in the same system was studied in column experiments. The results of these determinations are discussed. An ion exchange procedure for enrichment and decontamination of uranium from fission products and thorium-containing nitric acid solutions with the aid of a simple remoted handling apparatus is described. (auth)

4405 SEPARATION OF CESIUM AND BARIUM FROM RARE EARTHS IN THE ION SOURCE OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Nguyen-Long-Den (Institut de Physique Nucleaire, Orsay, France). J. Radioanal. Chem.; 5: No. 1, 107-13(May 1970). (In French).

In a previous work the separation of cesium from a lanthanum target bombarded by protons in the thermoionic ion source of an electromagnetic isotope separator was studied. After irradiation the principal elements found in the targets were Cs, Ba, Ce, and La. This method was extended to the separation of cesium and barium from metallic lanthanum targets and from lanthanum oxides. It is based on the thermoionization efficiency and on the behavior of the element studied in the heated cavity, which depends on its volatility if it is in metallic form, and on its reduction and on the volatility of resulting compounds if it is in compound form. In the metallic system cesium and barium were obtained on the collector successively with respective overall yields of about 5% and 0.2%. In the oxide system, cesium was obtained as Cs^+ ions and simultaneously barium as BaO^+ ions, which are separated from Ba^+ by 16 masses avoiding the interference with cesium isotopes. The overall yield of the barium separation is about 0.2%. A discussion on the value of barium ionization potential is given. (auth)

4406 RADIOCHEMICAL SEPARATIONS BY RETENTION ON IONIC PRECIPITATE ADSORPTION TESTS IN 11 MATERIALS. Girardi, F.; Pietra, R.; Sabbioni, E. (Joint Nuclear Research Center, Varese, Italy). J. Radioanal. Chem.; 5: No. 1, 141-71 (May 1970).

The retention of different radio ions on columns of eleven ionic precipitates from different acid media was studied, in view of possible applications for radiochemical separations. The results of about 2,000 adsorption experiments, carried out in a standardized way, are presented schematically in periodic tables. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 4217, 4379, 4380, 4427, 4444, 4611, and 4739.

4407 (BMI–171-140) GEOMORPHOLOGY AND PEDOLOGY OF AMCHITKA ISLAND, ALASKA. Final Report, July 1, 1969–June 30, 1970. Everett, Kaye R. (Ohio State Univ., Columbus). Nov 1971. Contract AT(26-1)-171. 86p. Dep. NTIS.

For Battelle Columbus Labs., Ohio.

Amchitka Island is composed of volcanic rocks and minor amounts of sandstones, conglomerates and glacial deposits; most rocks are fractured and faulted. Geomorphically the Island has been separated into six segments. The three eastern segments are characterized by upland areas with numerous shallow lakes and ponds with little or no drainage connection. The easternmost segment has only a shallow organic cover; the others are covered with 20 to 40 in. or more of organic soil. Elevations increase westward across the fourth segment where the organic soil mat is severely abraded in many places, and landslides, especially along steep coastal bluffs, and slumping in the headward areas of streams, are common. In the mountainous fifth segment, relief is maximum, as is erosion. The thick organic soils give way to easily fluidized mineral soils; mass-movement is evidenced by hillside terraces, solifluction lobes, and surface wash in the higher areas. A more sandy organic soil sequence occurs at lower elevations. Westward, the sixth segment is a plateau area with many characteristics of the the eastern segments. Seven distinct soil groups have been identified on the basis of their drainage, moisture content, character of peat, particle-size distribution of underlying mineral soil, position in the landscape, and natural stability. These soil groups that are mapped in detail form the basis for an assessment of the trafficability of the various soils, and their probable response to test-related disturbances. The soil characterizations provide a basis on which biological programs can draw for community distribution and pond chemistry. (auth)

4408 (DEMO–71/12) INVESTIGATION UNDER NATURAL CONDITIONS OF THE FEASIBILITY OF ^{51}Cr-E.D.T.A. AS TRACER OF KARST GROUNDWATER. Dimitroulas, C.; Leondiadis, J. (Democritus Nuclear Research Center, Athens (Greece)). Apr 1971. 16p. Dep. NTIS (U. S. Sales Only).

^{51}Cr-E.D.T.A. is used as tracer in a known karstic hydrological system, consisted of a sinkhole and a spring 4 km away, located in Peloponnese area. Underwater scintillation counters and carbon active columns were used for monitoring and enrichment of the tracer during sampling. All carbon active samples were analyzed with a 400 multichannel analyzer. Quantitative calculations showed that, even at concentrations of the order of 10^{-12} g/cc in chromium, Cr-E.D.T.A., at least in karstic systems, is still a reliable tracer. (auth)

4409 (USGS–474-105) HYDRAULIC-TEST AND QUALITY-OF-WATER DATA FROM HOLE U-3cn PS NO. 2, BILBY SITE, NEVADA TEST SITE. Garber, M. S. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 86p. (NTS–230). Dep. NTIS.

The Bilby Event occurred on Sept. 13, 1963 and was the first underground nuclear explosion within the zone of saturation in Yucca Flat. Hole U-3cn PS No. 2 was drilled into the Bilby rubble chimney. The drill hole was pumped five times from July 1964 to May 1966. Information is presented on the drilling and testing of hole U-3cn PS No. 2 and on the chemical, hydraulic, and radiochemical data obtained during the five pumping tests. (L.C.L.)

4410 (USGS–474-132) SUMMARY OF THE SUBSURFACE GEOLOGY OF THE CANNIKIN SITE, AMCHITKA ISLAND, ALASKA. Amchitka 6-4. Lee, W. H.; Gard, L. M. Jr. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 24p. Dep. NTIS.

The subsurface geology of the Cannikin site has been determined by examination of cuttings and cores from, as well as geophysical logs of, a 7,000-foot exploratory drill hole. Cuttings from the emplacement hole taken from the surface to 5,000 feet and cores and geophysical logs from a small diameter center-punched hole from 5,000 to 6,500 feet were examined. The correlation is made between the stratigraphic sections in the two holes. Some of the physical and chemical properties of the albitized and chloritized pillow basalt at the working point are briefly reviewed. (auth)

4411 FRACTIONATION OF THE ^{238}U DECAY SERIES IN THE ZEOLITIZATION OF VOLCANIC ASHES. Capaldi, Giuseppe; Civetta, Lucia; Gasparini, Paolo (Univ., Naples). Geochim. Cosmochim. Acta; 35: No. 10, 1067-72(Oct 1971).

U and Th contents and U, Th and Ra long-lived isotopes were measured in unaltered and in zeolitized Holocene volcanic ashes from the Phlegraean Fields, Campania, S. Italy. Ra, U and Th concentrations decrease with increasing zeolitization of the rock (Ra $\gg$ U > Th). In unaltered ashes, near-equilibrium conditions exist between ^{226}Ra and ^{230}Th. ^{226}Ra contents of strongly zeolitized ashes, however, are 40 to 50% lower than equilibrium concentration with the measured ^{230}Th. Equilibrium conditions prevail for the ^{232}Th series in all types of ashes. It is concluded that zeolitization processes lasted several thousand years after the eruption of the rock, but probably are not active at present, i.e., about 10,000 years after the eruption. (auth)

4412 PETROGRAPHIC AND CHEMICAL STUDY OF THE LOWER ORDOVICIAN URANIUM-BEARING SEDIMENTARY UNIT AT TAASJOE LAKE. Andersson, Astrid. Geol. Foren. Stockholm Forh.; 93: No. 544, 117-35(31 Mar 1971).

A uranium-bearing unit, stratigraphically classified as Lower Ordovician, is included in the border sedimentary sequence of the Swedish Caledonides at Taasjoe, Vaesternorrland County. The parts of the sedimentary rocks rich in uranium are characterized by the mineral association glauconite, calcite, siderite, dolomite, carbonate-fluor-apatite (marine apatite), and quartz. Most of the uranium is localized in the mineral apatite. Investigations of the way in which this mineral occurs in the rocks indicate that the uranium is syngenetic with the deposition of the sediment and the formation of the apatite. (auth) (Sweden)

4413 LANDSLIDES AND THE CHARACTERISTIC DISTRIBUTION OF RADIOACTIVITY. Amano, Nobutake; Ishidaira, Sadao (Public Works Research Inst., Niigata, Japan). Doboku Gijutsu Shiryo; 11: No. 12, 605-7(Dec 1969). (In Japanese).

It is generally recognized that the intensity of natural radioactivity in a landslide region tends to show a high value near the boundary between the moving and stable blocks, while the middle part of the moving block is rather low. The case of Amada Pass Landslide at the boundary between Toyama and Ishikawa prefectures is cited as one of the most conspicuous examples for this. In order to confirm this characteristic distribution of radioactivity in landslide regions, measurement was carried out at the Sarukuyoji landslide testing area in Niigata prefecture. There was the general tendency showing this characteristic, but due to the past geological disturbance in the stable block, the area showing high radioactivity was wider in extent. In case of the Kunimi Landslide in Toyama prefecture which developed in a fault zone, high value was detected along the apparent fracture line. In investigating a landslide region, zero background is necessary for practical purposes. The mean value of the measurement in a landslide area is enough to serve as a relative background. Radioactive methods should be used in a landslide region for checking the data obtained by other geophysical means. (Japan)

4414 UNIDIMENSIONAL INVERSE PROBLEM OF GAMMA WELL LOGGING. Davydov, Yu. B. (Inst. of Mining, Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 13: No. 2, 105-9(1970). (In Russian).

A solution was found to the unidimensional inverse problem of gamma well logging for the case of a complex distribution of a gamma-emitter along the seam width. Let the intensity distribution of gamma radiation along the axis of the seam be J = J (z). It is then required to find the distribution of the gamma emitter, assuming that the radioisotope content varies along the coordinate z in agreement with the relationship q = q (z), and the principle of additivity of the gamma emitter is observed. (K.S.W.)

4415 COUNTING UNIT FOR MEASURING THE ACTIVITY OF NATURAL RADIOCARBON BY LIQUID SCINTILLATION. Fontes, J. C. (Univ., Paris). Rev. Geogr. Phys. Geol. Dyn.; 13: No. 1, 67-86(Jan-Mar 1971). (In French).

Equipment for measuring the activity of natural radiocarbon by liquid scintillation is described. The successive stages involved in the synthesis of benzene are discussed. A commercial spectrometer equipped with an automatic sample changeover unit was used. The limit of detection is about 40,000 years if a counting time of 24 hours is adopted. A satisfactory agreement with samples dated in other laboratories was achieved. (France)

4416 PRE-OPERATIONAL ENVIRONMENTAL MONITORING PROGRAMS AT NUCLEAR FACILITIES. Golden, John Christopher Jr. Ann Arbor, Mich.; Univ. of Michigan (1971). 111p. University Microfilms Order No. 71-15,574.

Thesis.

The pre-operational environmental monitoring program at a modern nuclear facility includes extensive studies of background radioactivity, the abiotic physical-chemical environment, and the biotic assemblage of plants, animals, and microbes. This dissertation summarizes the history of radioactive materials in Lake Michigan, describes the present (1969 to 1970) radioactivity content of the lake, and forecasts the content in 1975. The primary radionuclides in Lake Michigan are of natural origin and from fallout of nuclear detonations. The radioactivity so far contributed by Big Rock Nuclear Power Plant is considerably less than one percent of the total activity in the lake water. The most significant natural radionuclides in the water are potassium-40 and carbon-14. At present, tritium, cesium-137, strontium-90, and yttrium-90 residual activity from fallout of nuclear detonations exceeds the activity in water from natural or other man-made sources. The chief radioelements in the sediment are the cesium-137 from fallout and natural radium, thorium, and potassium. The results of this investigation indicate that for the proper long-term management of reactor waste the following studies should be initiated: measurements of tritium and strontium-90 in lake water; further measurements of cesium-137 in lake water and sediment taken with core samplers; and extensive monitoring of strontium-90, cesium-137, and zinc-65 in fish, especially human food species, using a sampling program designed with fish biologists. Strontium-90 is one of the most hazardous nuclides discharged by reactors to water. Since most of the strontium-90 from fallout of nuclear detonations is still in the water medium and available to man in his food and drink, it would be useful to have good baseline data on this nuclide. The concentration of cesium-137 in lake water is very low and less than minimum detectable levels by conventional monitoring techniques. Better data on this nuclide in water and its vertical distribution in sediment are necessary before an accurate inventory can be made in Lake Michigan. The small size of the fish sample in the present study makes it difficult to estimate human dose from the consumption of fish. However, the sample of fish does indicate that very small quantities of reactor nuclides released to water can be reconcentrated in a human food. A study of stable element concentrations in the environment at a prospective nuclear facility is described. The objectives of the stable element study are to establish the maximum degree to which the radioactive materials discharged to water will be reconcentrated in human food derived from the water, to identify the limiting food pathways to man, and to select suitable monitor organisms for the radiological monitoring program. A study such as that described here is believed to be the best available method for estimating well in advance of operation, the potential exposure to man resulting from a release of radioactivity to the hydrosphere. A non-routine release of radioactivity into Lake Erie at Enrico Fermi Atomic Power Plant is discussed. This experiment is designed to measure under natural conditions the uptake of radioactivity by selected environmental media and compare these data to the sequence of levels expected from the stable element content. If the sequence of levels are related directly, then this method may provide an alternative and perhaps less costly way for locating monitor organisms. Two hundred millicuries each of the four radionuclides iodine-131, cobalt-58, cesium-137, and zinc-65, were to have been released at the reactor. Captive specimens of fish and fresh-water clams and samples of periphyton, sediment, water, rooted plants, and benthic organisms are available for sampling. (Diss. Abstr. Int., B)

4417 THEORETICAL STUDIES ON THE EFFECT OF CONDITIONS PREVAILING DURING BOREHOLE MEASUREMENTS ON THE CONFIGURATION OF CURVES OBTAINED BY THE γ METHOD. Larionov, V. V. Tr., Mosk, Inst. Neftekhim. Gazov. Prom.; No. 89, 122-32(1969). (In Russian).

Currently used interpretation of the curves obtained by the γ method to determine the intensity distribution of the natural γ radiation in boreholes does not take into account the scattered component of the γ radiation. This problem may be solved by considering the asymptotic nature of the build-up factor and the law controlling the passage of radiation through matter. In applying the pertinent equations, certain corrections were made in the formula giving the distribution of natural γ radiation I_γ within an uncased well, filled with a drilling fluid with a density of δ_f and a radioactive element content of q_f, intersecting a layer possessing of δ_l and a radioactivity of q_l. The mean γ energy of the rocks was calculated from the typical U, Th and K ratio in sandstones, expressed as radium equivalents. The derived formulas may be used for cased wells, usually filled with water possessing only a negligible amount of radioactivity. The curves obtained take the activity of the cement into account and may be used to determine the spatial distribution of I_γ when interpreting data obtained by the γ method. (TTT)

4418 MEASUREMENT OF THE RESIDUE WEIGHT IN SEDIMENTATION ANALYSIS OF A GRANULOMETRIC COMPOSITION OF PULP BY MEANS OF BETA-RADIATION ABSORPTION (EXCHANGE OF EXPERIENCE). Basin, A. A.; Balashov, V. N.; Ivanov, E. A.; Konoplina, R. P. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 12, 1904-5(Dec 1970).

Translated from Zavod. Lab.; 36: No. 12, 1489-90(Dec 1970).

A method for determining the thickness (or weight) of a layer of a substance based on the relation $I = I_0 e^{-(\mu m/\rho s)}$, where I_0 is the initial intensity of β radiation, I is the intensity after passage through the layer of the substance, m/s is the surface mass of the substances, and μ/ρ is the mass coefficient of absorption, was used. A ^{90}Sr radiation source having an activity of 10 μCi was used. For a known area of s cm^2 of the measured layer the graph of $\Delta I = f(m)$ can be represented in the form $\Delta I = f(c_s)$, where c_s is the weight of the layer. Thus, from the instrument indications it is possible to determine the weight of the precipitated layer. In order to verify the method tests were made on polymetallic ore having a coarseness of 200 mesh and containing ~1.3% lead. The error in measuring the residue weight is ±0.12 g when the residue weight is from 0.5 to 5 g. If the activity of the radiation source is increased to 20 to 30 μCi, the error is halved. (J.G.B.)

4419 PHYSICAL BASIS OF PULSED-NEUTRON WELL-LOGGING. Chrusciel, Edward; Massalski, Jerzy; Starzec, Antoni (Academy of Mining and Metallurgy, Krakow). Nukleonika; 15: No. 11-12, 773-95(1970). (In Polish).

The theoretical foundations for pulsed neutron well-logging are presented. The known methods of measuring the time distribution of thermal neutrons as well as gamma photons from the neutron capture reaction are also reviewed. The effect on the time distribution of thermal neutrons and photons of such factors as the length of the probe, kind of detector, borehole fluid and diameter, rock porosity, water mineralization, and saturation of the deposit with water, crude oil, or gas is discussed. The field methods for determining the thermal neutron mean lifetime are described, and compared with other geophysical techniques. (auth)

4420 DESIGN OF INJECTORS FOR EXPERIMENTS WITH RADIOACTIVE INDICATORS. Dobzhanski, Ya.; Korbel, K.; Obsyak, T. (Inst. of Nuclear Physics, Krakow). At. Energ. (USSR); 30: No. 4, 393-6(Apr 1971). (In Russian).

Increasing use of tagged atoms in scientific and technical investigations and measurements makes it necessary to design new types of injectors. Two types of injectors were designed and built to measure the flow rate of liquids in pipelines, and wells for hydrogeological and geophysical studies; pulsed fast and pulsed continuous instruments were used respectively for the two cases. The design solutions and constructional details are presented for several variations of these instruments. One of the types makes it possible to introduce simultaneously into the pipe line several grain-size fractions of solid matter or to inject a liquid phase. Several injectors were designed to determine the flow direction and rates in drilling pipe. (TTT)

4421 STRONTIUM AND LEAD ISOTOPES OF VOLCANIC ROCKS IN JAPAN. Kurasawa, H. (Geological Survey of Japan, Kawasaki). pp 666-70 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The strontium isotopic composition of the basalt of Japan becomes progressively radiogenic from the Pacific side to the Japan Sea side. In the northeast Honshu, however, the isotopic composition of the strontium is slightly radiogenic to the Pacific side, while much larger differences in $^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$ ratios have been observed for basalts and felsic differentiates in West Japan. (auth)

4422 ISOTOPE ABUNDANCE VARIATION AND THE EVOLUTION OF THE EARTH AND METEORITES. Shimazu, Y.; Urabe, T. (Nagoya Univ., Japan). pp 688-91 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The history of material transfer between crust and mantle as related to the behavior of trace elements is described. A model is described which is compatible with the behavior of the U–Pb system, the Rb–Sr system, and the lanthanide series. (J.R.D.)

4423 PREDICTABLE LOW ENRICHMENT OF METHANE ISOTOPES BY CLUSIUS–DICKEL THERMAL-DIFFUSION COLUMNS FOR USE IN RADIOCARBON DATING TECHNIQUE. Erlenkeuser, H. (Univ., Kiel). Z. Naturforsch.; 26a: No. 8, 1365-70(Aug 1971).

By means of the Clusius–Dickel thermal-diffusion column, the range of the radiocarbon dating method may be extended by 20,000 years. It is shown that the total sample amount required is reasonably low, if column dimensions are suitably chosen. The enrichment run time and the length of the thermal-diffusion column will allow sample enrichment in routine operation. Optimal values of column dimensions and operation conditions are calculated. With an all metal thermal-diffusion column that has been carefully constructed, a high reproducibility is found. The stationary as well as the nonstationary state operation are in agreement with column theory within 1%, concerning the enrichment both of $^{13}CH_4$ and $^{14}CH_4$ in methane. The theory has been evaluated by numerical methods. (auth)

4424 FISSION-TRACK AGES OF SOME INDIAN BIOTITES. Gupta, M. L.; Mehta, P. P.; Nagpaul, K. K. (Kurukshetra Univ., India). Indian J. Pure Appl. Phys.; 9: No. 7, 466-9(Jul 1971).

Some biotite pegmatites from Bihar, Rajasthan, and Andhra Pradesh were dated by fission-track method. Attention is drawn to the necessity of measuring uranium concentration only on tight cleavages and also using samples of uniform uranium distribution. The ages thus determined agree with the ages determined using muscovite samples, as well as with the ages of orogenic metamorphic cycles delineated by other radiometric methods. (auth)

Meteorology

Refer also to abstracts 4379, 4380, 4737, and 4742.

4425 (CEX-65,92) DIFFERENTIAL MEASUREMENTS OF FAST-NEUTRON AIR-GROUND INTERFACE EFFECTS. Project 9,2 of Operation HENRE. French, R. L.; Mooney, L. G. (Radiation Research Associates, Inc., Fort Worth, Tex.). Jul 1971. 29p. Dep. NTIS.

The effect of the air–ground interface on the scattered fast-neutron dose near the ground was measured at a distance of 1000 ft from a 14-MeV neutron source. The source was the HENRE accelerator operated at a height of 112 ft on the BREN tower at the Nevada Test Site. A horizontal slab of polyethylene 1 ft thick and 5 ft square with Hurst-type fast-neutron dosimeters mounted on its upper and lower surfaces separated the neutrons arriving through the upper 2π solid angle from those from the lower 2π. A third detector, mounted on a boom, measured the free-field. The entire assembly was suspended by a hoist system to make measurements at 0.75 to 70 ft above the ground. The scattered dose at the top detector was essentially constant, that at the bottom detector increased by a factor of approximately 2 between 0.75 and 70 ft, and the free-field dose increased by less than 25% over the same height range. The experiment provided confirmation, both qualitative and quantitative, of the first–last collision model of the air–ground interface effect. (auth)

4426 (COO-1199-20) STUDY OF RAINOUT OF RADIOACTIVITY IN ILLINOIS. Tenth Progress Report. Semonin, Richard G. (Illinois State Water Survey, Urbana). Nov 1971. Contract AT(11-1)-1199. 33p. Dep. NTIS.

The field project phase (ITREX) of the contract research during 1971 was continued in the St. Louis area as an integral part of Project METROMEX, a field effort to determine the effects of an urban area on precipitation. Unique chemical tracers released into the updrafts of convective clouds were used to estimate the scavenging efficiency of the treated clouds. The design of ITREX as it relates to METROMEX is described, and a few preliminary findings determined from the data collected during the field project period are given. (auth)

4427 (JUL-763-RG) EXPECTED TRITIUM CONTAMINATION FROM NUCLEAR REACTORS TO AIR AND WATER BY HOMOGENEOUS DISPERSION TO THE YEAR 2000. Boehnert, R.; Bonka, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). May 1971. 95p. (In German). Dep. NTIS (U. S. Sales Only).

Under the assumption of complete mixture, tritium concentrations in air and water to the year 2000 were calculated. For the calculation, future power produced by nuclear plants was selected in accordance with present projections. Comparison of calculated tritium concentrations in air and water showed that, within the next decades, the tritium problem will not be a general, but a local one. This fact is revealed by a model of West Germany whereby West Germany is conceived as a closed space. While worldwide mixtures lead to concentrations that are five orders of magnitude lower than the presently permissible concentrations, concentrations in the closed space model reach the permissible limit. In addition, all significant aspects of tritium evaluation are discussed as well as the computation methods for evaluating data. (tr-auth)

4428 (WASH-1187) MATHEMATICAL ANALYSIS OF THE EFFECTS OF WIND ON REDISTRIBUTION OF SURFACE CONTAMINATION. Amato, Amelio J. (Division of Biology and Medicine (AEC), Washington, D. C.). Sep 1971. 7p. GPO $0.25.

A theoretical model has been formulated to predict the long range, time and space, redistribution by wind of surface contamination. Creep, saltation, suspension (followed by diffusion and deposition), and weathering are considered to effect a one dimensional flow pattern spatially described by an unlimited number of continuous intervals. Within each interval the contamination concentration is described as a function of time by a first order differential equation. Possible applications and extensions are discussed. (auth)

4429 METHOD OF DETERMINING TOTAL RADIOACTIVITY OF ATMOSPHERIC FALLOUT. Aleksandrov, N. N. Tr. Gl. Geofiz. Observ.; No. 207, 110-20(1968). (In Russian).

In order to speed up the counting of filter samples, ashing of the sample was omitted by directly counting the filter material in a number of layers on a counter sensitive to soft beta radiation. The proportionality constant to convert actual count to total count takes into account the counting efficiency for beta radiation, the relative solid angle of count, self-absorption, and backscattering in the sample. After correcting for self-absorption in the filter paper it was found that good agreement was obtained between the new method of counting and the old method where counting was undertaken after ashing. (TTT)

4430 RADIOACTIVE CERIUM FALLOUT. Beck, J. N.; Thein, M.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Health Phys.; 21: No. 3, 466-70(Sep 1971).

Cerium isotopes were used as tracers of atmospheric transport processes. ^{144}Ce and ^{141}Ce data for daily fluctuations in ground-level air content after the 3rd, and subsequent, Chinese nuclear explosions, are reported during January 1966 at Fayetteville, Arkansas. Radioactivity was measured by a Tracerlab low-level β counting system. Variations of $^{141}Ce/^{144}Ce$ in rain are tabulated and the radioactive decay of this ratio in the stratosphere is shown. The graphical estimation of the percentage increase in ^{144}Ce in the stratosphere, due to a nuclear explosion, is explained. Bi-monthly average concentrations of ^{144}Ce in rain since 1962 are also shown, with the relevant assumptions noted. (UK)

4431 DETERMINATION OF DIFFUSION COEFFICIENTS IN THE PLANETARY LIMITING LAYER WITH Rn AND ThB. Guedalia, D.; Birot, A.; Fontan, J.; Allet, C. (Univ., Toulouse). Compt. Rend., Ser. B; 273: No. 1, 57-60(5 Jul 1971). (In French).

The diffusivity profile determination in the limiting layer, with Rn or Th–B, is discussed. For Th–B, it is possible to use only one vertical concentration distribution profile and to deduce the vertical diffusion coefficient profile from the diffusion equation in stationary regime. For Rn, two profiles at a distance of a few hundreds kilometers in the wind direction must be used. The diffusivity profiles determined in this way indicate that exchanges take place on the scale of a few hundreds kilometers. (France)

4432 RELATION BETWEEN DEUTERIUM AND ^{18}O CONTENTS IN RAIN WATER. Matsubaya, O. (Okayama Univ., Tottori, Japan); Miyake, Y. pp 724-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The relations between the deviation of deuterium content with that of oxygen-18 in fractionally collected rainwater were investigated. It was found that the deviation relations are linear and that part of the equation representing these linear relations have no constant term, while others have a constant term which varies in each rainfall. (J.R.D.)

Mineralogy and Exploration

Refer also to abstracts 4448 and 4550.

4433 (70-CNA-636) IMPLICATIONS OF ENERGY POLICY ON THE USE OF CANADIAN RESOURCES (WITH REFERENCE

TO URANIUM). Lowell, Alan F. (Rio Algom Mines Ltd., Toronto (Ontario)). 1970. 6p. (CONF-700564-11). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

A brief review is given on the current uranium situation in Canada, with some reference to those aspects of it that seem to relate to national, and possibly international, policies and which inevitably involve governments. (P.C.H.)

4434 URANIUM-BEARING LAYER FROM THE LOWER ORDOVICIAN, SWEDEN. Armands, Goesta. Geol. Foren. Stockholm Forh.; 92: No. 543, 481-90(15 Dec 1970).

The probable origin of the uranium-bearing sedimentary phosphorite rock in Vaesternorrland County, about 200 km N of the town of Oestersund, is discussed. Subzones 5a, 5b and 5c of the Olenid Series (Upper Cambrian) are exposed at Sjougdälven River. Twenty km to the SE only subzone 5a is present. The uppermost two subzones, especially 5c which contains Peltura scarabeoides, are richest in uranium. From a maximum of 200 ppM, the uranium content decreases rapidly downward in the series. The partial destruction of subzones 5c and 5b was a result of a regression. This was followed by a transgression during the early Ordovician. Most of the uranium in the radioactive zones is presumed to have originated in subzones 5c and 5b. A maximum concentration of about 1,000 ppM uranium was produced in the radioactive Ordovician rock through uranium substitution in phosphorite, a carbonate-fluorapatite. The sedimentary rocks richest in uranium should be sought in the most southeasterly parts of the Lower Ordovician, where the coastal areas of the Upper Cambrian were exposed to erosion and where the overlying Lower Ordovician units are phosphorite bearing. (auth) (Sweden)

4435 ECONOMIC AND TECHNICAL FACTORS CONCERNING URANIUM. Cavinato, A. Econ. Int. Fonti Energ.; 14: No. 1, 29-50(1970). (In Italian).

World uranium reserves are considered together with extracting costs. Market conditions of uraniferous minerals are examined and a short description of working cycles of ores is given. An economic evaluation of supply costs for U_3O_8 to be used in Italy for fueling two or three power plants and for other industrial and research applications is done. (INIS)

4436 MIMIC. Brinck, Johan. Euro-Spectra; 10: No. 2, 46-56(Jun 1971). (In French).

A computerized survey by MIMIC (Mining Industry Model for the Inventory and Cost Evaluation of Mineral Resources) of nonferrous metals was made. The methods of calculation both of resources and of costs of production are discussed. Calculations were based on possible resources of 80 million tons of exploitable uranium ore with an estimated need for the period 1970 to 2000 of 2.5 to 4 million tons, and a constant-value dollar in terms of gold. Long-term prices ($/half-kg) resulted as follows: U–6.00, Cu–0.35 to 0.45, Zn–0.10 to 0.20, and Pb–0.10 to 0.20. (K.S.W.)

Seismology

4437 (SC-RR-66-696) SURFACE MOTION RESPONSE SPECTRA, PROJECT SHOAL. Perret, William R. (Sandia Corp., Albuquerque, N. Mex.). Feb 1967. 103p. Dep. NTIS.

Particle velocity records derived from Shoal Project 1.2 surface stations at horizontal ranges between surface zero and 4775 feet were used to derive displacement response spectra for a range of frequencies between 0.5 and 100 cycles per second and five damping factors between zero and 10% of critical damping. These spectra were obtained from a computer program based on the solution of the equation for a simple damped oscillator driven by a particle velocity-time function representing ground motion. Space Technology Laboratory (Project 1.7) had installed reed gages adjacent to each Project 1.2 station, and reed response data were compared with computed displacements for frequencies identical with each reed frequency and five damping factors from zero to 10%. Results indicate that, of 94 reeds having frequencies below 100 cps, about 40% gave maximum displacements which fell between calculated values for the damping range zero to 10%, 23% gave displacements lower than computed values for 10% damping, and 37% gave displacements greater than computed values for zero damping. Explanation of the latter case is sought in the methods of gage installation. (auth)

4438 (UCID-30027) USER'S MANUAL FOR NTEDYNS: A NONLINEAR FINITE ELEMENT CODE FOR ANALYZING THE BLAST RESPONSE OF UNDERGROUND STRUCTURES. Takarz, Frank J. (California Univ., Livermore. Lawrence Radiation Lab.). 7 Jan 1971. 66p. Dep. NTIS.

This engineering note is intended for use as a user's manual for the computer code NTEDYNS. NTEDYNS is a nonlinear finite element code for analyzing the blast response of underground structures. Both axisymmetric and plane strain problems may be treated. Included are a brief summary of NTEDYNS capabilities, a block diagram, a description of each subroutine and a FORTRAN IV listing of the code. Also included are a detail description of "input data" required to run problems and a sample problem with "output." NTEDYNS is compatible with both the CHIP (CDC-6600 and CDC-7600) and the ORDER (CDC-7600) operating systems. (auth)

4439 (UCID-30028) INPUT SOIL PROPERTIES FOR THE FINITE ELEMENT CODE "NTEDYNS." Tokarz, F. J. (California Univ., Livermore. Lawrence Radiation Lab.). 3 May 1971. 11p. Dep. NTIS.

NTEDYNS is a nonlinear two-dimensional dynamic finite element computer code which is being developed to solve free-field ground shock problems as the result of underground nuclear explosions. Like other computer codes used to solve free-field ground shock problems, NTEDYNS is based on a mathematically defined constitutive model. The quantitive input for such constitutive models is based primarily on laboratory test data. The most common laboratory tests employed are the "uniaxial strain test" and "triaxial shear test." A summary is given which indicates the particular soil properties which are required to properly define the current constitutive relations used in NTEDYNS and to briefly outline how these properties can be obtained from an "uniaxial strain test." (L.C.L.)

4440 (UCRL-73428) SHOCK INPUT FOR EARTHQUAKE STUDIES USING GROUND MOTION FROM UNDERGROUND NUCLEAR EXPLOSIONS. Bernreuter, D. L.; Norris, D. M. Jr.; Tokarz, F. J. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Sep 1971. 10p. (CONF-711110-2). Dep. NTIS.

From forty-second shock and vibration symposium; Key West, Fla. (2 Nov 1971).

Comparisons are made between the ground motion from earthquakes (EQs) and underground nuclear explosions (UNEs). It is shown that peak g-levels and response spectra form a reasonable basis for comparison. Several approaches which attempt to characterize the time history are also discussed. It is shown that: the peak g-levels from UNEs have magnitudes comparable to those estimated for the strongest EQs; the spectra from UNEs are similar to those from EQs; and a time history comparison shows that both the duration of strong motion and the number of near-peak g-level cycles for UNEs fall within the range established for strong EQs. Based on these results it is concluded that ground motion from UNEs can provide an EQ-like environment for testing full-scale structures. (auth)

4441 DISCRIMINATION BETWEEN SMALL-MAGNITUDE EARTHQUAKES AND EXPLOSIONS. Evernden, J. F. (Advanced Research Projects Agency, Washington, D. C.); Best, W. J.; Pomeroy, P. W.; (and others). J. Geophys. Res.; 76: No. 32, 8042-55(10 Nov 1971).

Data are presented that address the problem of discrimination between earthquakes and explosions of small magnitude ($3\frac{3}{4} \leq m_b \leq 4\frac{3}{4}$). Data sources include various long-period seismometer installations in the United States. The data suggest that long-period discriminants useful at $m_b \geq 4\frac{3}{4}$ remain as useful at $m_b \geq 4$. The conclusion is also drawn that detection of the surface wave of $m_b = 4$ earthquakes can be accomplished at distances of from 6000 to 7000 km. (auth)

4442 SHORT-PERIOD P-WAVE GENERATION BY RAYLEIGH-WAVE SCATTERING AT NOVAYA ZEMLYA. Greenfield, R. J. (Pennsylvania State Univ., University Park). J. Geophys. Res.; 76: No. 32, 7988-8002(10 Nov 1971).

The teleseismic P-wave signal from underground explosions at Novaya Zemlya Island was followed by a coda lasting several minutes. The power level of the coda was measured on Lasa beams for two explosions and on five single seismometer records for one explosion. Using a statistical approach, the measured coda level can be explained by assuming that the coda is a result of scattering of source-generated Rayleigh waves to P body waves by the island coastlines, river valleys, and other topographic features that are found within a few hundred kilometers of the source. The rate at which the coda decays with time is consistent with the hypothesis of coda generation by scattering. (auth)

4443 EXCITATION OF SEISMIC SURFACE WAVES WITH PERIODS OF 15 TO 70 SECONDS FOR EARTHQUAKES AND UNDERGROUND EXPLOSIONS. Savino, J.; Sykes, L. R.; Liebermann, R. C.; Molnar, P. (Columbia Univ., Palisades, N. Y.). J. Geophys. Res.; 76: No. 32, 8003-20(10 Nov 1971).

Using data from high-gain seismographs operating in the deep (543-meter) mine observatory at Ogdensburg, New Jersey, the excitation of long-period surface waves by earthquakes and underground explosions for four different regions of the world: western United States, the Aleutians, Novaya Zemlya, and Central Asia were analyzed. The most important result of this study is that discrimination between earthquakes and underground explosions on an $M_s - m_b$ basis is enhanced when the amplitudes of Rayleigh waves with periods near 40 sec, rather than 20 sec, are used to determine M_s. A discriminant based on surface waves with periods near 40 sec is particularly advantageous because of a very stable and pronounced minimum in earth noise in this period range. Love waves also yield a distinct separation between earthquakes and explosions on the basis of M_s (Love) at 20 and 40 sec with m_b and can be used for discrimination of small events for which no Rayleigh waves are recorded. The discrimination threshold at Ogdensburg is $m_b' \simeq 3.8$ for the western United States at a distance of about 30° and $m_b \simeq 4.4$ for the Aleutians at 70°. All the events studied could be discriminated by using 40-sec Rayleigh waves. Amplitude spectra of Rayleigh waves in the period range 15 to 70 sec were computed for events in the western United States, the Novaya Zemlya region, and the Aleutians. The spectral amplitudes decrease more rapidly with increasing period for explosions than for earthquakes in the western United States and Novaya Zemlya. These spectral differences are consistent with an impulsive source time function for explosions. In the Aleutians, however, the shape of the spectrum of long-period waves for the underground explosion Milrow is similar to spectral shapes for some, but not most, nearby earthquakes. Two plausible explanations for this spectral similarity are contamination of the Milrow spectrum by earthquake-generated Rayleigh waves, or the effects of focal depth and radiation pattern on the earthquake spectra. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 4407, 4409, 4410, 4437–4440, 4442, 4443, 4512, 4527, and 5251.

4444 (NVO–1229–145(Pt.1)) EVALUATION OF THE PROJECT DRIBBLE SITE, HATTIESBURG, MISSISSIPPI, FOR DISPOSITION, INCLUDING IDENTIFICATION OF RESTRICTIONS. Gardner, M. C.; Downs, C. E. (Teledyne–Isotopes, Palo Alto, Calif.). Mar 1971. Contract AT(29–2)–1229. 49p. Dep. NTIS.

The site of the Project Dribble underground nuclear and high explosive detonations was studied to assess conditions and make recommendations pertinent to disposal from Atomic Energy Commission proprietorship and supervision. Disposal of a nuclear event site should be considered from the standpoint of security, radiological safety, and structural safety in a logical sequence of criteria application. Criteria developed for disposal of Shoal, Nevada, and Gnome, New Mexico, sites were applied to the Dribble site. The cavity and an area near Well HT-2 used for radioactive waste disposal contain melt and debris, and recovered wastes, respectively, whose analysis might reveal classified information. However, after sealing Station 1A hole, access to either of these underground places would require extensive drilling and completion effort. Exclusion of drilling and mining equipment from within 300 ft of Ground Zero and 600 ft of Well HT-2 is recommended. Security considerations would not prevent release of the site to public domain and private ownership under this condition. Radioactive materials at the site surface are being surveyed by both directed and random grid instrument and sample collection and analysis techniques. Debris found to be contaminated should be removed. Soil found to be contaminated should be removed or mixed with clean fill and distributed under fresh soil cover to avoid exposure and leaching to possible sorbing clay horizons. Subsurface radioactive materials are confined to the cavity, some fractures in salt at the cavity margins, and to a small area with radius less than 150 ft in the Cook Mountain Limestone (Aquifer 5) near Well HT-2. Isolation of these radioactive areas will probably continue. The cavity is isolated from the groundwater system. Fluids in Aquifer 5 move at less than 10 ft/yr. Collapse of the present cavity is improbable. Five wells are recommended for retention for water quality and pressure monitoring purposes; one new hole near HT-2 is recommended for monitoring aquifers 4 and 5. Freshwater aquifers in the region of the site have very low gradient and slow rate of water movement. No radionuclides above Concentration Guide levels are forecast to enter freshwater aquifers. Further disposal of wastes in saline Aquifer 5 is not recommended, in order to avoid hydraulic pressure increase at the contact with Tatum Salt Dome, one-half mile distant. Except for drilling and mining restrictions, the site is recommended for release to its occupants for agricultural pursuits. (auth)

4445 (PNE–1006) PROJECT GASBUGGY: ON-SITE RADIOLOGICAL SAFETY DURING PRODUCTION TESTING, JANUARY 25, 1968–DECEMBER 31, 1969. (Eberline Instrument Corp., Santa Fe, N. Mex.). 20 Aug 1971. Contract AT(26–1)–294. 44p. (PNE–G–77). Dep. NTIS.

Eberline Instrument Corporation provided on-site radiological safety support services for Project Gasbuggy during production testing. Gas released by flaring was monitored by a system that measured the tritium and krypton (^{85}Kr) concentrations. Tritiated liquid wastes removed by bulk liquid separators were analyzed for tritium and then released as vapor in the gas flare. The total amount of tritium and ^{85}Kr released as vapor or gas during production testing through December 31, 1969, was 2432 and 364 curies, respectively. Personnel working on-site during production testing did not receive any significant radiation exposure from the tritium or ^{85}Kr. (auth)

4446 TEMPERATURE-CONTROL SYSTEM. Elliott, Adelbert J.; Jones, Milton O. (to United States Atomic Energy Commission). U. S. Patent 3,603,107. 7 Sep 1971. Filed 28 Apr 1970.

An explosive device temperature control is described wherein the high temperature effect of an environment is minimized by isolating the explosive and a low-temperature medium from the environment. This is accomplished by enclosing within the apparatus comprising a container including a removable end closure, first and second open-ended double-walled housings each having an outer wall supported by the container and an inner wall spaced from the outer wall with heat-insulating barrier between, the container maintaining the double-walled housings in axial alignment with the open ends thereof in substantially abutting relationship with each other. (Official Gazette)

Facilities and Equipment

Refer also to abstracts 4429, 4446, 5022, 5236, and 6257.

4447 (ORNL–NSF–EP–6) PRELIMINARY ASSESSMENT OF A POTASSIUM–STEAM–GAS VAPOR CYCLE FOR BETTER FUEL ECONOMY AND REDUCED THERMAL POLLUTION. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W–7405–eng–26. 52p. Dep. NTIS.

Both fuel supply and thermal pollution considerations that are becoming progressively more important strongly favor the development of a higher temperature, and more efficient, thermodynamic cycle for electric power plants. Results of about 200,000 hr of operation of boiling potassium systems, including over 15,000 hr of potassium vapor turbine operation under the space power plant program, suggest that a potassium vapor topping cycle with a turbine inlet temperature of ~1500°F merits consideration. A design study has been carried out to indicate the size, cost, and development problems of the new types of equipment required. The results indicate that a potassium vapor cycle superimposed on a conventional 1050°F steam cycle would give an overall thermal efficiency of about 54% as compared with only 40% from a conventional steam cycle. Thus the proposed system would have a fuel consumption only 75% and a heat rejection rate only 50% that of a conventional plant. The system uses clean fuel, and advantage is taken of the present trend toward eliminating SO_2, NO_x and ash emissions. Results of the assessment at this stage show that the capital cost may be less than that of a conventional plant. The main reason for this is use of pressurized combustion, which leads to a much smaller combustor, and thin tube walls to contain potassium at about the same pressure. (auth)

4448 POWER SOURCES FOR PORTABLE PROSPECTING EQUIPMENT FOR RADIOACTIVE MATERIALS. IEC Publication 201 1965. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1965). 4p (In French and English). Available from American National Standards Institute, New York.

Specifications are presented for the size and voltage rating of Type R 20 primary cells for use as power supplies in self-contained portable equipment for radioactive ore prospecting. (L.C.L.)

4449 EXPERIMENTAL SODIUM LOOP ML-2. de la Torre Cabezas, Manuel (Junta de Energie Nuclear, Madrid). Energ. Nucl. (Madrid); 15: No. 70, 92-101(Mar-Apr 1971). (In Spanish).

In the development of fast breeder reactors, sodium technology plays an important role since it is the most frequently used coolant. The sodium circuit ML-2 presently under construction is described. There are several objectives for this loop, the most important of which is the development of an apparatus which makes it possible to determine the oxygen content of sodium in-line by the vacuum distillation method. (tr-auth)

4450 EQUIPMENT FOR SEPARATING A FLAT DEVICE FROM ITS PROTECTIVE WRAPPING. Duport, Philippe; Eschbach, Jean; Marchal, Paul (to Commissariat a l'Energie Atomique). French Patent 2,045,172. 15 Feb 1971. Filed 12 Jun 1969. (In French).

Equipment is described for mechanically separating a thin flat device (generally rectangular) from its protective wrapping, the principal application envisaged being the separation of a dosimetric film from its aluminized polyethylene wrapping. The equipment accomodates a continuous feed by means of moving rollers, situated as close as possible to the rollers which perform the stripping. (France)

4451 APPARATUS FOR COMPUTING CONVEYOR BELT MASS FLOW RATE INCLUDING A RADIOACTIVE SOURCE DETECTOR AND SLIDE-WIRE LINEARIZER MULTIPLIER. Brelin, Richard E.; Wooden, Lawrence F. (to Detroit Edison Co.). U. S. Patent 3,610,925. 5 Oct 1971. Filed 15 Oct 1969.

Structure for and a method of determining the mass of material moving past a predetermined point on a conveyor belt is described. Included is a radioactive C-frame through which the conveyor belt passes operable to provide a signal proportional to the density of the material on the belt passing through the C-frame, rotating wheel structure maintained in contact with the conveyor belt for providing a signal proportional to the speed of the conveyor belt

as it passes through the C-frame, and structure for linearizing the signal from the C-frame and providing a functional multiplication of the density signal and conveyor belt speed signal to provide an output signal proportional to the mass of material passing through the C-frame. A mass rate indicator and a total mass register provides desired indications of the mass moving on the conveyor belt in response to the output signal proportional to the mass of material. (Official Gazette)

4452 THEORY OF A ROTATING HEAT PIPE. Chan, S. H. (New York Univ., N. Y.); Kanai, Z.; Yang, W. T. J. Nucl. Energy; 25: No. 10, 479-87(Oct 1971).

Based on a simple model, an analytical solution is obtained to predict the heat transfer rate of a wickless heat pipe which is conical in shape and rotates about its longitudinal axis. The rotating heat pipe utilizes centrifugal force, instead of capillaries, for the return-pumping of the condensate. The heat transfer rate of the rotating heat pipe is then compared with the existing data for a conventional capillary heat pipe to demonstrate the merit of the former. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 4447, 4452, 6266, and 6376.

4453 (GEAP-10164) DEFICIENT COOLING. Second Quarterly Progress Report, October 1–December 31, 1969. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec 1969. Contract AT(04-3)-189. 36p. Dep. NTIS.

Research progress in the second quarter, Oct. 1 to Dec. 31, 1969, for the Deficient Cooling Program, is reported. Detailed planning and scheduling of one- and nine-rod tests to be performed in the third and fourth quarters were completed. Design and procurement of materials for one-rod power and flow cycling tests was completed. Procurement of calrod heaters for the nine-rod tests was initiated. Calrods with both uniform axial heat flux variations were ordered. Analyses and procedures for data reduction of system pressure and flow transients, as measured by either a turbine- or orfice-meter, were completed. (auth)

4454 (GEAP-10341) DEVELOPING TWO-PHASE FLOW IN TUBES AND ANNULI. PART I. EXPERIMENTAL RESULTS, CIRCULAR TUBE. PART II. ANALYTICAL STUDIES, TUBES, AND ANNULI. Janssen, E.; Kervinen, J. A. (Pt.I); Kim, H. T. (Pt.II) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb 1971. Contract AT(03-4)-189. 126p. Dep. NTIS.

Experimental and theoretical studies of developing two-phase flow in tubes and annuli were conducted. Tests were run in a 0.68 in. ID tube test section, with steam–water at 1000 psia flowing vertically upward. Measurements were made of the flow in the annular region next to the wall (the film region), by an isokinetic sampling technique, using concentric splitters which split off the sample flow from the rest of the flow. Film thickness was measured using a conductivity probe. Pressure drop was measured under both adiabatic and boiling conditions. The results are presented. A theoretical model was derived for describing the flow rate in the liquid film for fully developed two-phase annular flow in a circular tube. Comparison of computed results with measured data showed a satisfactory agreement (75% of the data lay within 15% of prediction). An expression for the net interchange rate of liquid droplets between core and liquid film regions, for developing adiabatic two-phase annular flow in vertical annuli was derived. The net interchange process rate is proportional to the departure of the film from its equilibrium state, as well as being a function of various system variables. The analysis shows that the liquid film flow rate (both rod and tube) approaches its equilibrium value asymptotically. The model was compared with the rod and tube film growth data of Moeck for developing adiabatic steam–water flow in a vertical annulus at high pressures. The predictions compare favorably with the measured values (80% to 85% of the data lie within ±15% of prediction). Both analysis and annulus data indicate that the higher the mass flow and the pressure and the lower the quality, the longer the developing length will be. This quality effect is in contrast with that indicated by the circular tube data. The analytical approach used in the present study may be extended to formulate a critical heat flux model which predicts the dryout point at which boiling heat transfer in the annular regime breaks down. (L.C.L.)

4455 (KFK-tr-371) VELOCITY DISTRIBUTION IN THE CELL OF A DENSELY PACKED ROD BUNDLE. Levchenko, Yu. D.; Subbotin, V. I.; Ushakov, P. A.; Sheynina, A. V. Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from pp 223-34 of Zhidkie Metally. Sbornik Statei, Atomizdat, Moscow, 1967. 17p. (In German). Dep. NTIS (U. S. Sales Only).

This paper was abstracted from the original language and appeared in NSA as 22: 10497. (J.R.D.)

4456 EFFECT OF PITCH ON HEAT TRANSFER FROM ROD CLUSTERS IN LONGITUDINAL TURBULENT COOLANT FLOW (Pr ≥ 1). Borishanskii, V. M.; Gotovskii, M. A.; Firsova, E. V. (Central Boiler and Turbine Inst., Leningrad). Heat Transfer–Sov. Res.; 3: No. 4, 91-9(Jul-Aug 1971).

The results of a heat transfer experimental study of longitudinal turbulent coolant flow past rod bundles with relative pitches of S/d = 1.1, 1.3, 1.4, and 1.5 are presented. A method for correlating the experimental data and a design heat transfer equation is given. (auth)

4457 BURNOUT EQUATIONS FOR WATER BOILING IN ROD BUNDLES. Efimov, V. A. Heat Transfer - Sov. Res.; 3: No. 4, 76-84(Jul-Aug 1971).

A verification is presented of the empirical relationship $K = 1\Sigma\eta_i$ ($K = q_{cr}/q_{cr\,0}$, where q_{cr} is the critical heat flux for the bundle, while $q_{cr\,0}$ is the same for a simple channel, for the same flow variables of the coolant, averaged in the crisis-inception cross section i.e., x_{cr}, $\bar{\omega}_\rho$, ρ_i η_i is a factor incorporating the effect on $q_{cr} = f(\bar{x}_{cr}, \bar{w}_p, p)$ of each of the features peculiar to coolant flow in rod bundles) for determination of the critical heat flux. It is assumed on the basis of published experimental results with relatively loosely packed rod bundles and moderate void fractions that $\Sigma\eta_i = \eta_{cell} + \eta_{surf}$, where η_{cell} is the coefficient of thermal and hydraulic inequivalence of flow-channel cells, which allows for the reduction in $q_{cr} = f(\bar{x}_{cr}, \bar{w}_p, p)$ due to enthalpy peaks in "hot" cells, η_{surf} is the coefficient of thermal and hydraulic inequivalence of surfaces in "hot" cells, which allows for the reduction in $q_{cr} = f(\bar{x}_{cr}, \bar{w}_p, p)$ due to the higher enthalpy near the "hot" surfaces. Correlation of available data yields particular relationships between coefficients η_{cell} and η_{surf} on one hand, and bundle geometries and coolant flow variables on the other. (auth)

4458 HEAT TRANSFER TO STEAM-WATER ANNULAR DISPERSED FLOW IN VERTICAL ANNULUS. Ikemoto, Ichiro; Takayasu, Masaharu; Ueno, Nobuyuki; Michiyoshi, Itaru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 400-5(Jul 1971).

The heat transfer coefficient and slow burnout heat flux were measured for a stream-water annular dispersed upward flow under pressures up to 3.5 atm abs in an electrically heated vertical annular channel. An empirical equation was derived for the heat transfer coefficient as function of mass flow rate, steam quality and heat flux. The dominant mechanism of heat transfer to the annular dispersed two-phase flow is forced convection of liquid film on the heater surface even in the region of low steam quality (down to about 0.03). The observed slow burnout heat flux was near the point of intersection of the lines representing liquid film forced convective heat transfer and nucleate boiling heat transfer on the q vs. ΔT_{sat} diagram. A dryout mechanism is proposed in which increasingly violent evaporation comes to impede the rewetting of the dry patches generated on the heater surface, which thus spread to cover the whole surface. A maximum value is observed in the slow burnout heat flux plotted against exit steam quality. This can be explained as the effect of heat removal by droplet exchange between liquid film and steam flow. (auth)

4459 RAPID TRANSITION IN BOILING HEAT TRANSFER OF ENLARGED HEATING SURFACE. Takeyama, Toshio (Tohoku Univ., Sendai); Ouchi, Masaki; Shoji, Yoshiaki. Nippon Kikai Gakkai Rombunshu; 37: No. 296, 750-6(Apr 1971). (In Japanese).

From pool boiling experiments on an enlarged heating surface with a one dimensional fin, a rapid transition phenomenon was observed, which differed from the burnout boiling curve in normal pool boiling. Heat transfer of the enlarged heating surface is discussed on the basis of experiments with various kinds of fins. The experimental apparatus consisted of a heating surface with a fin in a pool and heater circuit. Heat transfer was calculated from temperature measured with thermocouples. Boiling phenomena were photographed. Three kinds of mixed boiling phenomena were observed. First, nucleate boiling on the heating surface and natural convection at the fin, secondly, transient boiling and convection, and thirdly, film boiling. These are explained in terms of mixed boiling curves. Boiling heat transfer on the enlarged heating surface is controlled by heat transfer at base of the plate surface. By increasing the temperature of the plate surface, the heat transfer may be controlled by the fin. All experiments with various kinds of fins resulted in burnout boiling curves which showed a rapid transition phenomenon as compared with normal boiling curves. (Japan)

4460 EQUIVALENCE OF TRANSIENT HEAT GENERATION AND TRANSIENT SURFACE TEMPERATURE BOUNDARY CONDITIONS IN HEAT CONDUCTION. Friedland, Aaron J. (Atomic Power Development Associates, Inc., Detroit). Nucl. Eng. Des.; 16: No. 2, 151-2(1971).

Two common classes of transient heat conduction problems are those with no heat generation and the surface or surrounding medium temperature a prescribed function of time, and those with prescribed uniform heat generation and constant surface or surrounding medium temperature. It is pointed out that the solution to any problem in one of these classes is also a solution to a problem in the other class. At any time t, the difference between the temperature at any location and the surface temperature in a body with no heat generation and surface temperature $f_4(t)$ is the same as that in the given body with constant surface temperature and volumetric heat generation $Q = -C\rho\, \partial f_4/\partial t$. (auth)

4461 ANOMALOUS CHOKING CONDITIONS RELATED TO TWO-PHASE PRESSURE DROP COMPUTATIONS. France, D. M.; Stein, R. P. (Argonne National Lab., Ill.). Int. J. Heat Mass Transfer; 14: No. 9, 1407-13(Sep 1971).

Unacceptable anomalous upstream choking conditions are shown to occur at low qualities when using the most commonly applied engineering model for computing two-phase (liquid–vapor) pressure drop. The direct relation between this condition and the mathematical prediction of a maximum value of the critical mass velocity in regions where quality approaches zero, is noted. Although computations for vapor–liquid sodium flows are emphasized, it is noted that similar difficulties will also exist with water flows. Upstream choking is shown to result from use of four different representations of the Lockheart–Martinelli vapor volume fraction correlation as well as from three other void correlations, two of which are specifically suggested for application to liquid metals. (auth)

4462 BOUNDARY VORTICITY METHOD FOR LAMINAR FORCED CONVECTION HEAT TRANSFER IN CURVED PIPES. Akiyama, Mitsunobu; Cheng, K. C. (Univ. of Alberta, Edmonton). Int. J. Heat Mass Transfer; 14: No. 10, 1659-75(Oct 1971).

A finite-difference solution using a combination of line iterative method and boundary vorticity method is presented for the hydrodynamically and thermally fully developed laminar forced convection in curved pipes subjected to the thermal boundary conditions of axially uniform wall heat flux and peripherally uniform wall temperature at any axial position. The numerical solution converges up to a reasonably high Dean number where the asymptotic behavior for the flow and heat transfer results already appears. The Prandtl number effect on heat transfer result is clarified for the first time, and it is shown that all the heat transfer results for $Pr \geq 1.0$ can be correlated by a single curve using a new parameter (K^2Pr) with reasonable accuracy. The numerical results from the present analysis are compared with the experimental and theoretical results available in the literature. The perturbation method is shown to be invalid, and some inconsistency in the boundary-layer approximation method is pointed out. (auth)

4463 BURNOUT IN FORCED CONVECTIVE FLOW IN STRAIGHT VERTICAL CHANNELS. Hewitt, G. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inst. Fuel; 44: No. 368, 540-9(Oct 1971).

The nature and relevance of the burnout phenomena is reviewed and the need for understanding the mechanism is demonstrated. Differences between pool boiling and forced convective burnout are illustrated and it is shown that the phenomenon is governed, in forced convective flow, by the two-phase flow mechanisms in the channel. Studies on two-phase flow are described which show that burnout commonly occurs in the annular flow regime. Visualization studies of burnout in this regime are outlined and a description is given of the use of film flow measurements to obtain a quantitative evaluation of the mechanisms. The importance of liquid entrainment from the film into the vapor flow is stressed and the mechanisms of such entrainment discussed. The effects of tube length and heat flux of entrainment are discussed in terms of the entrainment curve. The determination of droplet deposition rates is described for both air–water and steam–water flows. Deposition provides a limiting case of burnout and gives an indication of various zones of burnout which are then discussed. Finally, possible future developments of this type of work are reviewed. (auth)

Isotope Technology

Refer also to abstracts 4376, 4408, 4611, 4926, 5899, 5915, 6082, and 6084.

4464 (ISS–70/13) RESULTS OF CONTROL MEASUREMENTS FOR THE SEALING OF SOME RADIUM SOURCES FOR THERAPEUTIC USE. Grisanti, A.; Tori, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 22 Apr 1970. 11p. (In Italian). Dep. NTIS (U. S. Sales Only).

The hermetic sealing of the radium γ sources for therapeutic purposes was checked in Piemonte and Lombardia. Results are given and the experimental apparatus and methods are described. (auth)

4465 (KFK–1456) ACTINIDE PROJECT: FIRST SEMI-ANNUAL REPORT, 1971. (Kernforschungszentrum, Karlsruhe (West Germany)). Jul 1971. 138p. (In German). Dep. NTIS (U. S. Sales Only).

The actinide project of the Nuclear Research Center at Karlsruhe is subdivided into five sections: a special installation was erected for the production of ^{238}Pu, ^{242}Cm, ^{244}Cm, and ^{252}Cf from reprocessing products. 1. Present studies aim at the establishment of flux schemes for the isolation of americium and curium. 2. For reactor irradiation, targets are being developed for ^{237}Nb, ^{241}Am, ^{243}Am, and and ^{244}Cm. Parameter studies for an optimal and safe target concept are under way. 3. Chemical processing of irradiated transuranium elements aims at separation of Pu, Cm, and Cf. 4. Component development and prototype studies are conducted for process and cell techniques in which irradiated targets can be handled. 5. Planned are encapsules! ^{238}Pu sources for heart pacemakers. Also planned is the production of ^{252}Cf sources. Application of ^{252}Cf sources in neutron radiography and neutron activation analysis are studied in cooperation with other research institutes as well as with industry. (H.B.G.)

4466 (ORNL–4770, pp 105-8) MATERIALS DEVELOPMENT FOR ISOTOPIC POWER PROGRAMS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

A new alloy containing platinum, rhodium, and tungsten has been developed comparable to refractory alloys in strength properties but retaining the superior oxidation resistance of the noble alloys. This solid solution alloy, designated Pt-3010, can be fabricated, is weldable, and melts above 2000°C. Methods for fabricating thoria-molybdenum cermets using molybdenum powders were investigated; the products were compared with cermets produced by chemical vapor deposition of the molybdenum. The cermets produced by hot pressing CVD-molybdenum-coated thoria were superior in thermal conductivity and strength. Techniques for fabricating molybdenum-thoria cermets as stand-ins for Mo-$^{244}Cm_2O_3$ and noble metals-$^{244}Cm_2O_3$ cermets are also being investigated. These cermets with controlled porosity have been fabricated to provide for helium release and at the same time maintain desirable strength. The compatibility of ^{244}Cm and ^{90}Sr compounds with candidate container materials was ascertained for times to 10,000 hr. Plasma-arc welding was successfully applied to Hastelloy C capsules fueled with ^{90}Sr titanate. This technique overcame many of the difficulties associated with remote gas-tungsten arc welding. (auth)

4467 (PAEC(A)IN–716) IODINE ISOTOPES 131 (^{131}I): A LITERATURE SEARCH. (Philippine Atomic Energy Commission, Manila). Jul 1971. 334p. Dep. NTIS (U. S. Sales Only).

A bibliography of references appearing in Nuclear Science Abstracts covering the period August 1948 to December 1970 is presented. (J.R.D.)

4468 THERMAL DIFFUSION FACTORS FOR THE ^4He–^3He SYSTEM. Taylor, W. L.; Weissman, Stanley (Mound Lab., Miamisburg, Ohio). J. Chem. Phys.; 55: No. 8, 4000-4 (15 Oct 1971).

The thermal diffusion factor for the ^4He–^3He system has been measured from 200 to 900°K and as a function of composition at 215, 273, 373, and 473°K. These measurements were made in a 20-tube trennschaukel which allowed the use of a rather small temperature difference relative to the absolute temperature. The other experimental parameters were adjusted to minimize the corrections for trennschaukel operation. The data demonstrate a marked decrease in α_T with increasing temperature and a composition dependence of approximately 10%. The experimental values were compared to theoretical calculations using six different intermolecular potentials. The Lennard–Jones (12–6) and modified Buckingham (exp-6) potentials were inadequate but two recently proposed multiparameter functions represent the data quite well. (auth)

4469 EFFECT OF CHEMICAL EXCHANGE BETWEEN D_2 AND HBr ON THE THERMAL DIFFUSION SEPARATION OF D AND H IN A TRENNSCHAUKEL. Mathur, B. P. (Colum-

bia Univ., New York). J. Chem. Phys.; 55: No. 8, 3966-9(15 Oct 1971).

The effect of chemical exchange on the thermal diffusion separation of isotopes is investigated by use of a "trennschaukel" and the results of the limited investigation of the D_2–HBr system are reported. Although the system has some advantages for investigating the magnitude of the various effects that occur, it turned out to be a rather complicated system because of the number of species present (D_2, HD, H_2, HBr, DBr) and the corrosive nature of HBr. The D_2–HBr system was studied first without catalysis of the exchange reaction, and then with a platinum catalyst present. Without a catalyst, considerable concentration of deuterium occurs in the hot region. With a catalyst, the isotopic equilibria are established among the species with D being transferred preferentially to the bromide molecules which then concentrate in the cold region. However, this effect and the thermal diffusion effect for D_2 and HD relative to H_2, which also tend to concentrate D in the cold region, were not sufficiently large to make the overall ratio $(D/H)_{hot}/(D/H)_{cold}$ less than 1. This ratio without catalysis was between 1.4 to 1.1 depending on the mole fraction of D in the D_2–HBr mixture. With catalysis of the exchange reaction, the ratio was reduced to between 1.2 and 1.05 without significant dependence on the concentration of deuterium in the mixture. (auth)

4470 CURRENT PRACTICE IN THE SAFETY TESTING OF RADIATION SOURCES. Andrews, F.; Fletcher, K. E. (Radiochemical Centre, Ltd., Amersham, Eng.). Radioisotopes (Tokyo); 20: No. 7, 349-59(Jul 1971).

Methods of radiation source safety testing are examined. Four categories of testing are considered including testing during manufacture, testing for transport, and testing for use. (J.R.D.)

4471 RADIOACTIVE TRACER APPLICATIONS IN THE STUDY OF FLOW REACTORS. III. A METHOD OF MEASURING GREAT VELOCITIES IN TUBE REACTORS. Kubin, M.; Thyn, J. Radioisotopy; 11: No. 1, 101-50(1970). (In Czech).

The technical problems associated with measuring large gas velocities (above 100 $msec^{-1}$) in industrial conditions are discussed. In measurements on a tube reactor used for petroleum pyrolysis a modified peak timing method was used, where the tracer substance is injected as a liquid and evaporates under the given physical conditions in a sufficiently short time. The counting rate changes were recorded by means of a high-speed camera connected to an oscilloscope. (auth)

4472 RADIOISOTOPE HEAT SOURCE BOILER FOR POWER GENERATORS. Cohen, Michel; Lavigne, Pierre; Sauvagnac, Robert (to Commissariat a l'Energie Atomique). British Patent 1,245,386. 8 Sep 1971. Priority date 17 Jun 1969, France.

A radioisotope-heated boiler for power generation is described. The radiation source is ^{60}Co or ^{90}Sr in the form of plates which are submerged in high-boiling polyphenyl. Heat from the decaying radioisotope is transferred to the boiler by Cu heat blocks revolving and submerged in the liquid polyphenyl. Shielding is provided by the polyphenyl, external layers, and the heat blocks. (J.R.D.)

4473 BOILER WITH A RADIATION SOURCE FOR POWER GENERATOR HEATING. Cohen, Michel; Lavigne, Pierre; Sauvagnac, Robert (to Commissariat a l'Energie Atomique). French Patent 2,050,551. 22 Mar 1971. Filed 17 Jun 1969. (In French).

A boiler with a radiation source for power generator heating intended to be used with a converter is presented. This boiler consists of a cylindrical stainless steel vessel with an external heat-insulating coating, a radiation heat source (^{60}Co or Sr), a boiler whose base forms the tightly sealed lid of the vessel, and a safety part fusible at a given temperature. (France)

4474 SELFLUMINESCENT COMPOUNDS. Loriers, Jean (to Commissariat a l'Energie Atomique). French Patent 2,043,922. 8 Feb 1971. Filed 2 May 1969. (In French).

High yield self-luminescent compositions, which do not degrade significantly in time, for converting radiation from radioelements into light, and then possibly into electricity were developed. These compositions consist of an optically neutral matrix with at least one photoactivator and one radioactivator. The optically neutral material is a Y, La, Lu, Sc, Ca, Sr, Zr, Th oxide, vanadate or oxysulfur. The photoactivators are lanthanides except for La and Lu. (France)

4475 TECHNIQUES AND ECONOMY OF PRODUCTION OF HEAVY WATER. Report of the Nuclear Conference held at Turin, 30 September–1 October 1970. Serie Simposi. Rome; Comitato Nazionale Energia Nucleare (1971). 282p. (In several languages). (CONF-700925).

Fifteen papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 4476–4490.

4476 DEVELOPMENT OF THE HYDROGEN SULFIDE-WATER DUAL TEMPERATURE TECHNOLOGY. Spevack, J. S. (Deuterium Corp., White Plains, N. Y.). pp 23-45 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Development of methods for separating heavy water from light water is reviewed with particular attention directed to the improved dual temperature H_2S–H_2O isotope exchange process designated the GS process. It is noted that computer programs have been developed for analysis of the process. (J.R.D.)

4477 HEAVY WATER PRODUCTION BY AMINE-HYDROGEN EXCHANGE. Bancroft, A. R.; Rae, H. K. (Chalk River Nuclear Labs., Ont.). pp 47-66 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Research directed toward development of a process for production of heavy water by aminoethane–hydrogen exchange is described. Discussions are included on process design, process chemistry and comparison with other processes. (J.R.D.)

4478 PRODUCTION OF HEAVY WATER IN FRANCE. Roth, E. (CEN, Saclay, France); Rostaing, M. pp 67-74 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971). (In French).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The French studies on the NH_3–H_2 and H_2S/H_2O processes for the production of heavy water are summarized. (J.S.R.)

4479 OPTIMIZATION OF A HEAVY WATER PRODUCTION PLANT WITH THE AMMONIA-HYDROGEN DUAL TEMPERATURE EXCHANGE SYSTEM. Schindewolf, U.; Lang, G. (Univ., Karlsruhe, Ger. Kerforschungszentrum, Karlsruhe, Ger.). pp 75-90 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Optimization of the dual temperature process for heavy water production is reviewed. Discussions are included on one- to three-stage hot–cold enrichment system, a three-stage enrichment stripping system, and a combination of the enrichment stripping system with a transfer column. (J.R.D.)

4480 TECHNICAL DEVELOPMENTS OF THE LOW TEMPERATURE PROCESS FOR HEAVY WATER RECOVERY AND ITS ECONOMIC RESULTS. Gutowski, H. (Linde Aktiengesellschaft, Munich). pp 91-101 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

A low temperature process is described which is used at 25°K to separate D_2 from H_2 by rectification. Process diagrams are included. (J.R.D.)

4481 EFFICIENCY OF A CONCURRENT MASS EXCHANGE PLATE. Brigoli, B.; Ascoli, A. (CISE, Milan). pp 103-16 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

An evaluation of distillation column plate efficiency (Murphrees efficiency) is presented. The calculation method adopted is general. As an iterative method, it requires extended calculations, however, considering the computer aid and the rapid convergence of the iterative procedure, the method described may represent a useful tool for estimating the Murphree's efficiency of a distillation plate, or more generally of a cocurrent mass exchange plate, even during planning or design. The test of its reliability in other pressure and temperature conditions would be welcome. (J.R.D.)

4482 FABRICATION AND CONSTRUCTION EXPERIENCE FOR BRUCE AND PORT HAWKESBURY HEAVY WATER PLANTS. Spray, P. H. G. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 119-38 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Aspects of fabrication of heavy water production plants are discussed. The GS process involving exchange between water, heavy water, and hydrogen sulfide is used. Information and discussions are presented to show that the outstanding feature of design, fabrication, and construction of the heavy water plants is quality control. Knowledgeable design, careful selection of materials of construction, and rigid fabrication requirements are controlled by intensive inspection and quality surveillance. The techniques and organization developed for the design and construction of nuclear facilities have been applied, with modification, to the design of a chemical process facility to a degree not formerly experienced in the industry. The result is a safe plant, with a long operating life, and the best possible guarantee of satisfactory operation that good design practice can supply. (J.R.D.)

4483 PROBLEMS RELATED TO THE DESIGN OF A PLANT FOR THE PRODUCTION OF HEAVY WATER: CONTRIBUTION OF AGIP NUCLEARE. Bracciforti, L.; Cabella, A.; Valentini, P. Duranti (Agip Nucleare S.p.A., Milan). pp 139-72 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971). (In Italian).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The design of a plant for the production of heavy water using the dual temperature hydrogen-ammonia exchange is discussed. The experimental apparatus needed to determine the industrial feasibility of such a plant are described. (J.S.R.)

4484 PROBLEMS OF THE DESIGN AND CONSTRUCTION OF A PLANT FOR HEAVY WATER PRODUCTION USING THE DUAL-TEMPERATURE AMMONIA-HYDROGEN EXCHANGE SYSTEM. Walter, S.; Nitschke, E. (Friedrich UHDE GmbH, Dortmund, Ger.). pp 173-95 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Results of pilot plant runs used in design of dual temperature heavy water production plants are discussed. Information is included on basic design possibilities for a production plant, final concentration, gas purification, design of plant for synthesis of NH_3 and production of heavy water, aspects of construction, and cost factors. (J.R.D.)

4485 HEAVY WATER PLANT AT MAZINGARBE. DESCRIPTION AND OPERATION. Lefrancois, B. pp 197-208 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971). (In French).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The Mozingarbe heavy water plant produces heavy water by the ammonia–hydrogen exchange at one temperature. The plant is described with a consideration of the gas purification, isotopic exchange, ammonia dissociation, and recovery and recycling of the catalyst. The principal characteristics of the plant are given. The operation of the plant is described including the coupling of the ammonia plant, gas purification, isotopic exchange, corrosion, catalysts, control, and safety. (J.S.R.)

4486 DESIGN CRITERIA FOR HEAVY WATER PLANT BASED ON H_2S–H_2O EXCHANGE PROCESS. Bhargava, R. K.; Sadhukhan, H. K.; Sehgal, I. J. S.; Deshpande, P. G. (Bhabha Atomic Research Centre, Trombay, India). pp 209-26 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The various parameters that contribute to the design of the cascade based on H_2S–H_2O exchange process for production of heavy water are outlined. It is seen that these are to be judiciously selected to arrive, at optimum design conditions giving due consideration to the plant location. (auth)

4487 NATURAL WATER DISTILLATION PLANT: A NEW TECHNICAL APPROACH. Selecki, A. (Warsaw Technical Univ.). pp 227-37 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The potential advantages of multiple use of heated vapors in multiple effect distillation plant for heavy water production are examined. The results obtained suggest that revising old projects on the use of the geothermal steam may be of interest. It appears that under specified circumstances the multiple effect distillation plant might at present be economically commensurable with others. Further detailed engineering studies on the proposed method should be continued. (J.R.D.)

4488 ECONOMICS OF HEAVY WATER MANAGEMENT. Russell, S. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 241-53 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Heavy water management techniques in the Canadian nuclear industry are reviewed. Information and discussions are included on heavy water capital costs and heavy water management costs. (J.R.D.)

4489 OPERATIONAL AND ECONOMIC ASPECTS OF HEAVY WATER PRODUCTION AT NANGAL BASED ON LIQUID HYDROGEN DISTILLATION. Bimbhat, K. S. (Bhabha Atomic Research Centre, Trombay, India). pp 255-67 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

The plant is designed to produce about 14 tons per year of heavy water by fractional distillation of hydrogen obtained by electrolysis of water. This production is based on processing 5000 nm^3/hr of feed hydrogen from the third stage of the electrolysis plant containing 880 ppM HD, with a stream efficiency of 8000 hours and recovery of 90%. The enriched hydrogen is routed through the heavy water plant, where HD is separated and the depleted hydrogen returned to the ammonia plant. The feed hydrogen is compressed, purified, liquefied, and fractionally distilled in stages to produce 100% hydrogen deuteride, which is passed over a catalyst to bring about isotopic equilibrium. The mixture of hydrogen, deuterium and HD so obtained, is finally fractionally distilled to yield better than 99.98 percent deuterium, which is oxidized with pure oxygen in the presence of a catalyst to produce heavy water. (auth)

4490 CONSIDERATIONS ON A DUAL PURPOSE DUAL TEMPERATURE PROCESS FOR PRODUCING D_2O. Marchetti, C.; Simon, R. (CCR-EURATOM, Ispra, Italy). pp 269-82 of Techniques and Economy of Production of Heavy Water. Rome; Comitato Nazionale Energia Nucleare (1971).

From Symposium on the technical and economic aspects of heavy water production; Turin, Italy (Sep-Oct 1970). See CONF-700925.

Deuterium enrichment by isotopic exchange between H_2 and H_2O in a system adapted to produce heavy water and electric power is discussed. The model examined requires 14 recycles to obtain an overall enrichment factor of 100. (J.R.D.)

4491 NEUTRON SOURCES IN INDUSTRIAL NEUTRONOGRAPHY. Settipani, A. (Societe Qualitest, Levallois-Perret, France). Ind. At.; 15: No. 3, 61-6(Jul 1971). (In French and English).

Neutronography can be used to reveal internal structures, insensitive to x-ray methods, and thereby constitutes an indispensable complementary technique. Various types of neutron sources are described. Although fast neutrons have been used, thermal and even cold neutrons are preferred. Such neutrons can be obtained from isotope sources, nuclear reactors, and particle accelerators. The thermal neutrons must be intense to provide good quality pictures. Although isotope sources, and accelerators have the advantage of mobility, their use is sometimes limited, because of their low yields. Nuclear reactors are the most widely used sources. (France)

4492 ELECTROMAGNETIC DEVICE FOR SEPARATION OF FLUID ISOTOPES. Greber, Henry U. S. Patent 3,594,573. 20 Jul 1971. Filed 20 Jun 1968.

This invention is related to an electromagnetic device for separation of the heavier isotopes from the lighter from a mixture of the two in a fluid, particularly in gaseous state. This device consists of an essentially cylindrical enclosure with at least one of its circular walls covered with n coils, whose centerlines are spaced from each other by angles equal to 360°/n, and are fed from an n-phase source of AC, with each phase passed at least through a half-wave rectifier. Said coils create a radial magnetic field which rotates around the longitudinal axis of said cylindrical enclosure. The rotating magnetic field acting on positive ions of the gas pushes them toward the periphery of said enclosure. The ionization of said gas is brought about by means of a radioactive material emanating ionizing radiation, and/or a corona, or arc discharge between two electrodes, with the space between them passed by the gas. The ions of the lighter isotope, due to its smaller mass, have a larger velocity than have the ions of the heavier isotope. Therefore, the ions of lighter isotope are gathered at the periphery of said enclosure, from where they are directed through pipes, whereas the ions of the heavier isotope leave said enclosure near its center. Said difference in velocities of the ions of the different isotopes can also be achieved by means of a toroidal coil arranged at an entrance nozzle to said enclosure. (Official Gazette)

4493 ^{252}Cf PROGRESS. NUMBER 8, JULY 1971. Californium-252 Progr.; No. 8, 1-56(Jul 1971).

ACTIVATION ANALYSIS—neutron sources for, evaluation of californium-252
CALIFORNIUM-252—purchase of, cost and shipping containers for
—uses of, demonstration of
—production of compacts, pellets, rods, and wires of, method for
—shipping of, domestic and foreign agents for
—dose rate from, during radiotherapy
CELLS—radiation effects on animal and plant, RBE for californium-252 neutron
EXPONENTIAL PILES—development of subcritical assembly-californium-252, for flux multiplication
MOISTURE GAGES—testing of radiometric, using californium-252 source
NEUTRON SOURCES—fabrication of californium-252, self-contained precipitation method for
—shipping of californium-252, design of container for
—evaluation of californium-252, for radiography
—shielding of californium-252, materials for
—fabrication of californium-252, for power reactor startup
—development of subcritical assembly-californium-252, for flux multiplication
NUCLEAR MATERIALS MANAGEMENT—neutron sources for, development of californium-252
PROSPECTING—neutron sources for, development of californium-252
RADIOGRAPHY, INDUSTRIAL—neutron sources for, development of californium-252
REACTOR FUEL ELEMENTS—analysis of, evaluation of californium-252 system for
REACTORS, POWER—startup of, fabrication of californium-252 neutron source for
SOILS—density and moisture of, evaluation of californium-252 neutron source for measuring
URANIUM OXIDES—analysis for uranium-235, use of californium-252 neutron source for
WELL LOGGING—neutron sources for, development of californium-252 (R.C.K.)

4494 ^{252}Cf PROGRESS. NUMBER 9, OCTOBER 1971. Californium-252 Progr.; No. 9, 1-49(Oct 1971).

ACTIVATION ANALYSIS—neutron source for, evaluation of californium-252
CALIFORNIUM-252—shielding materials for
—development of compacts, pellets, rods, and wires of, evaluation of method for
—sales of encapsulated
—neutron spectra of, in D_2O and graphite moderator
FLUORINE—determination in inorganic and organic fluorine compounds by neutron activation using californium-252
GASES—fluorescence of, evaluation of californium-252 as excitation source for
METHYL SULFOXIDE—moisture content in, evaluation of californium-252 neutron source for measurement of
NEUTRON SOURCES—evaluation of californium-252, for well logging
—analysis of encapsulated californium-252, counting methods for
—development and evaluation of californium-252, for use in radiotherapy
—evaluation of californium-252, for industrial radiography
—flux for californium-252, effects of configuration on
NEUTRONS—effects on pig skin, tolerance tests on californium-252
NUCLEAR MATERIALS MANAGEMENT—neutron sources for, development of californium-252
OILS—analysis for vanadium, development of on-stream analyzer for thermal neutron activation
PROSPECTING—neutron sources for, development of californium-252
RADIATION DETECTORS, SCINTILLATION (SOLID)—development of on-stream, for vanadium determination in crude oil
RADIOAPPLICATORS—dose distribution around californium-252, γ and neutron
RADIOGRAPHY, INDUSTRIAL—neutron sources for, evaluation of californium-252
REACTOR FUEL ELEMENTS—analysis of, evaluation of californium-252 neutron source system for
SHIELDING—effectiveness of concrete wall, use of californium-252 neutron source for testing
SKIN—radiation effects on pig, tolerance tests on californium-252 neutron
SWINE—radiation effects on skin of, tolerance tests on californium-252 neutron
VANADIUM—determination in crude oil, development of on-stream analyzer for thermal neutron activation
WATER—content in methyl sulfoxide, evaluation of californium-252 neutron source for measurement of
WELL LOGGING—neutron sources for, evaluation of californium-252
—neutron sources for, development of californium-252 (R.C.K.)

4495 ^{252}Cf PROGRESS. Californium-252 Prog.; No. 7, 1-52(Apr 1971).

ACTIVATION ANALYSIS—neutron source for, development of californium-252
CALIFORNIUM-252—sales of
—encapsulation of
—shipping of, availability of containers for
—dose to pig skin, tolerance tests on
—dose from radiotherapy source of
—shipping and storage of, development of container for
—optimization of moderator systems of, for reactor fuel element assay
CELLS, CULTURED—radiation effects on multiplicity of Chinese hamster, californium-252 neutron
NEUTRON SOURCES—evaluation of californium-252, for therapy of interstitial and surface lesions
—development of californium-252, for use in activation analysis
—properties and uses of californium-252
NEUTRONS—effects on multiplicity of cultured Chinese Hamster cells, RBE for
NUCLEAR MATERIALS MANAGEMENT—neutron sources for, development of californium-252
PROSPECTING—neutron sources for, development of californium-252
RADIOGRAPHY, INDUSTRIAL—neutron sources for, development of californium-252
REACTOR FUEL ELEMENTS—analysis of, optimization of californium-252 moderator systems for
SKIN—radiation effects on pig, tolerance tests on californium-252 neutron
SWINE—radiation effects on skin of, tolerance tests on californium-252 neutron
WELL LOGGING—neutron sources for, development of californium-252 (R.C.K.)

4496 FAST SEPARATION OF HEAVY PARTICLES BY ELECTROMAGNETIC GAS-FILLED MASS SEPARATORS. Armbruster, P.; Eidens, J.; Grueter, J. W.; Lawin, H. (Kernforschungsanlage, Juelich, Ger.). pp 520-34 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The operating principle of the gas-filled separator is described. Results of measurements on properties of heavy ions relevant to the separation technique are given, and the gas-filled separators under construction for investigation of fission products are described. (W.H.K.)

4497 GAS DISCHARGE ION SOURCE FOR AN ELECTROMAGNETIC MASS-SEPARATOR ON-LINE WITH A HEAVY ION CYCLOTRON. Tarantin, N. I.; Kabachenko, A. P.; Demyanov,

A. V.; Ivanov, N. S. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 548-61 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).
From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Characteristics of a gas-discharge ion source for an electromagnetic isotope separator on-line with a heavy ion cyclotron are described. Experiments using the on-line mass separator are summarized. (J.R.D.)

4498 CONTROL OF HOLE SIZE IN FILTERS BY MEASURING THE AMOUNT OF RADIATION PASSING THROUGH HOLES AND CORRESPONDINGLY CONTROLLING SPEED OF FILTER MOVING THROUGH ETCHING BATH. Robkin, Maruice A.; Porter, Charles R. (to General Electric Co.). U. S. Patent 3,585,395. 15 Jun 1971. Filed 6 Sep 1966.

A method and an apparatus for continuously manufacturing a filter web including continuously measuring and controlling hole size are disclosed. This system basically includes an etching tank through which a fission-fragment irradiated web is fed to etch holes in it, a radiation means on one side of the etched web and a radiation detector on the other side which is adjusted to measure only radiation which at least partially passes through holes in the web. A means responsive to this measurement is used to adjust web residence time in the etchant to maintain hole size in the desired range. (Official Gazette)

4499 PREPARATION OF RADIOACTIVE SOURCES OF Fe, Cd, In, Sb, Sn, Bi, AND Tl BY INTERNAL ELECTROLYSIS ON THIN METALLIZED PLASTIC FILMS. Bellemare, M.; Roy, J. C. (Univ., Laval, Quebec). Nucl. Instrum. Methods; 97: No. 1, 131-7(1971). (In French).

Spontaneous electrodeposition has been used to prepare radioactive sources of Fe, In, Cd, Sn, Sb, Bi, and Tl on metallized plastic films having a total thickness of about 40 $\mu g/cm^2$. The method is based on the use of a cell where the anode (a magnesium ribbon) and the cathode (the metallized plastic film) are separated by two fritted glass discs. Furthermore, electrodeposition is achieved from a solution (the catholyte) having a volume of about 0.04 ml. Techniques and experimental conditions have been developed to obtain metallic deposits of a few micrograms to several hundred micrograms per square centimeter with yields of 85 to 95% in 15 minutes of cell operation. The radioactive isotopes ^{59}Fe, ^{114m}In, ^{115m}Cd, ^{113}Sn, ^{125}Sb, ^{207}Bi, and ^{204}Tl, have been used for these studies. Based on results obtained, a set of rules for the deposition of traces of metals on thin metallized plastic films from an aqueous solution is given for preparing radioactive sources. (auth)

Materials Testing

Refer also to abstracts 4450, 4491, and 4927.

4500 (ANL-7832) DESIGN PROCEDURES FOR MATCHED AND BROADBANDING FILTERS FOR SCANNING TESTS. Cox, Cyrus W. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 23p. Dep. NTIS.

Design procedures are set forth for matched filters to improve the fidelity in scan-type nondestructive tests. The realizations are approximate, as such realizations must be, but the procedures used are relatively simple and straightforward. Adjustments of a design to accommodate changes in scanning speed and to allow use of nominal component values are also included. (auth)

4501 (CONF-700660) PROCEEDINGS OF THE CONFERENCE ON UTILIZATION OF NUCLEAR TECHNOLOGY IN INDUSTRIAL OPERATIONS, JUNE 8-9, 1970, CHARLESTON, WEST VIRGINIA. Series 71, No. 2-1. Shafer, Raymond E. (ed.) (West Virginia State Technical Services. West Virginia Univ., Morgantown. Southern Interstate Nuclear Board, Atlanta, Ga.). Aug 1970. 107p.

Industrial radiography and its application to process control are discussed. The coal and oil industries are specifically cited. Pertinent aspects of radiation safety are outlined, including the USAEC licensing and inspection programs. (R.W.R.)

4502 (ORNL-4770, pp 100-1) NONDESTRUCTIVE TESTING TECHNIQUES FOR LMFBR. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Methods, techniques, and equipment are being developed for nondestructively inspecting LMFBR cladding and structural materials, with emphasis on measuring cold work in type 316 stainless steel tubing for FFTF fuel-pin cladding. Theoretical equations, computer programs, and calibration equipment were developed leading to new eddy-current instrumentation to identify both the size of a flaw and its depth below the surface. Ultrasonic schlieren techniques are being used to improve understanding of weld inspection. A transducer with multiple sensors was developed. Delta and schlieren techniques are being correlated on a stainless steel sample that scatters ultrasonic energy excessively. Magnetic permeability measurements are being used in both flat and tubular type 316 stainless steel to determine cold work. A low-frequency eddy-current bridge was designed, constructed, and used to inspect tubing and rod with good results. A new coil system was designed to improve the sensitivity to changes in permeability. (auth)

4503 (ORNL-4770, pp 136-9) NONDESTRUCTIVE TEST DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Analytical studies of eddy-current phenomena were continued with emphasis on development and use of computer programs to solve specific problems. Phase-sensitive eddy-current instrumentation was stabilized at high frequencies. Improved models and experimental techniques for flaw characterization by ultrasonic frequency analysis were developed and confirmed on test specimens containing artificial flaws. The acousto-optic equipment was modified and stabilized to allow studies of schlieren, Bragg diffraction, and holographic techniques with less concern about loss of optical alignment. Several combinations of cladding and base materials were studied by scattering and fluorescence generated by ^{147}Pm radiation. To increase accuracy and inspection speed, work was initiated with an x-ray unit and a mechanical scanner. Preliminary calibration curves and resolution studies show promise for using closed-circuit television for interpretation of radiographs. A conceptual design was completed for a laboratory facility for neutron attenuation studies using ^{252}Cf. (auth)

4504 MECHANICAL TESTING MACHINE STIFFNESS. PART II. APPLICATION TO DATA REDUCTION. Hockett, John E. (Los Alamos Scientific Lab., N. Mex.); Gillis, Peter P. Int. J. Mech. Sci.; 13: 265-75(1971). (LA-DC-11155b).

A method of using mechanical testing machine stiffness in the reduction of load–time data to stress and strain, for constant crosshead-speed machines and for constant strain-rate machines is described. This technique, of explicitly calculating values of machine stiffness and using these values in data reduction, is compared with the frequently used method of measuring offset times, from the initial slope line of the load–time trace, and using these times to calculate points on a stress–strain curve. The differences between the two methods are small unless the change of machine stiffness during a test may be determined. When this is possible—and tests can nearly always be conducted so that it is possible—the technique in this work is superior to earlier, approximate methods. It is superior in accuracy of data reduction and in the fact that strain rates for all data points are more accurately calculated. (auth)

4505 MECHANICAL TESTING MACHINE STIFFNESS. PART I. THEORY AND CALCULATIONS. Hockett, John E. (Los Alamos Scientific Lab., N. Mex.); Gillis, Peter P. Int. J. Mech. Sci.; 13: 251-64(1971). (LA-DC-11155a).

The importance of elastic interaction between specimen and testing machine in many mechanical property tests is discussed, and drawbacks to the usual methods of calculating machine stiffness are considered. Two expressions are proposed for calculating the effective testing machine stiffness, which is actually a composite stiffness including machine, grips or platens, load cell, insulation, and lubricant. This stiffness is calculated from data acquired during compression tests in the LASL Cam Plastometer. The derived expressions can be adapted to calculate stiffness of many types of programmed testing machines; and they are so adapted to apply to both tensile and compressive testing in constant crosshead speed machines. Stiffnesses were calculated for over 200 tests in the LASL Cam Plastometer, and for a few tests in compression and a few in tension in constant crosshead speed machines. From the results of these calculations it was concluded that machine stiffness is a variable quantity which generally tends to increase as the applied load increases. Under sensibly identical experimental conditions there are large differences in calculated stiffnesses and it was concluded that it is necessary to perform such calculations for each mechanical test. Only by so doing can the specimen–machine interaction be properly taken into account when calculating stress–strain curves from load–time or load–displacement data. (auth)

4506 HOLOGRAPHIC INTERFEROMETER FOR ISOPACHIC STRESS ANALYSIS. Chau, Henry H. M. (to United States Atomic Energy Commission). U. S. Patent 3,587,301. 28 Jun 1971. Filed 19 Dec 1968.

A holographic method and apparatus are described for real-time isopachic (equal optical path) stress analysis of specimen materials having photoelastic stress-optic properties for structural analysis of stressed structures and shapes. The novel holographic interferometer provides a means of detecting and measuring stress zones inside a structure or shape. (Official Gazette)

4507 NEUTRON RADIOGRAPHY. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst., Oarai). Radioisotopes (Tokyo); 20: No. 4, 188-200(Apr 1971). (In Japanese).

A review of the history of neutron radiography, principle of the neutron radiography, neutron sources, method of exposure, and application of the neutron radiography is presented. Radiography is useful for precise examination of dense or thick materials such as sintered molybdenum parts and thick Pb sheets, materials composed of light elements having strong absorption of neutrons, such as various materials containing boron, solid fuels used for space vehicles, explosives, gasoline and oil, and composite materials made of metals with similar specific gravity. For example, high frequency cables may be examined with the neutron radiography. Transmission images obtained by this method are much clearer than those obtained using x rays. The exposure is made either by direct exposure method or by image transfer method. Time of the exposure is given by exposure charts. The neutron sources used for this purpose are nuclear reactors, neutron generators, and radioisotopes, such as Ra$-\alpha-$Be, Rn$-\alpha-$Be, and Ra$-\alpha-$B. From these neutron sources, neutrons with 0.024 to 0.83 MeV are produced; the half decay time being between 54 min and 1620 yrs. (Japan)

4508 METHOD AND APPARATUS FOR MEASURING ADHESION OF MATERIAL BONDS. Anderholm, Nordin C.; Goodman, Albert (to United States Atomic Energy Commission). U. S. Patent 3,605,486. 20 Sep 1971. Filed 21 Jan 1970.

A method is described for measuring adhesion of one material to another and tensile strength of the bond between these materials by producing a pulse of tensile stress in the materials and subjecting the bond to the tensile stress such as by impinging a pulse of radiant energy against a surface of one of the materials to produce a compressive stress wave within the material, reflecting the stress wave from a free surface of the other material, and subjecting the bond between the materials to the reflected tensile wave. The strength of the bond may be determined by incrementally increasing the tensile stress wave amplitude to effect bond failure and the tensile strength determined by measuring this amplitude. (Official Gazette)

4509 METHOD OF COMPUTING THE NUMBER OF PHOTOGRAPHS IN X-RAYING AND GAMMA-RAYING THE CIRCULAR WELDED SEAMS OF PIPELINES. Udralov, Yu. I. (Central Scientific Research Inst. of Metallurgy and Welding, Leningrad). Sov. J. Nondestruc. Test. (Engl. Transl.); No. 4, 373-7(Jul-Aug 1969).

Translated from Defektoskopiya; No. 4, 10-15(Jul-Aug 1969).

A method of computing the number of photographs in x-raying and gamma-raying the circular welded seams of pipelines through one and two walls is described. Formulas are cited which permit determining the number of photographs as a function of the focusing distance, of the dimensions of the controlled pipe, and of the given ratios between the thicknesses which are the most and the least translucent for a single exposure, or of the value of the maximum angle attained between the direction of radiation and that normal to the film. (auth)

4510 INDISTINCTNESS AND FREQUENCY-CONTRAST CHARACTERISTICS OF GAMMA-OPTICAL CONVERTERS. Yakobson, A. M. Sov. J. Nondestruc. Test. (Engl. Transl.); No. 1, 66-73(Jan-Feb 1969).

Translated from Defektoskopiya; No. 1, 77-86(Jan-Feb 1969).

A method is proposed for a theoretical estimate of the frequency-contrast characteristics and resolution of a screen-type gamma-optical converter based on the experimentally measured value of the intrinsic indistinctness (blur) of the screen. The effect of indistinctness of the edges of an image of a flaw on its detectability in gamma-optical conversion is examined. (auth)

Protective Structures

Refer also to abstracts 4438 and 4439.

4511 UNDERGROUND UTILITY TUNNELS. Boegly, W. J. Jr.; Griffith, W. L. (Oak Ridge National Lab., Tenn.). Mech. Eng.; 93: No. 9, 27-32(Sep 1971).

The feasibility of installing underground walk-through utility tunnels in urban areas and of using these tunnels for civil defense shelters was investigated. Utility tunnel systems that exist in U. S. cities (Fairbanks, Alaska and Denver, Colo.) and at numerous institutions, mainly universities, are described. The design of a tunnel system proposed for the White Plains, N. Y. Central Renewal Project and the advantages of such systems in new cities and urban renewal areas are discussed. (L.C.L.)

Radioactive Material Handling

Refer also to abstracts 4427, 4470, 4493–4495, 4609, and 4992.

4512 REDUCTION OF RADIOACTIVITY IN A NUCLEAR CHIMNEY AFTER STIMULATION OF A GAS RESERVOIR. Dunlap, Henry F. (to Atlantic Richfield Co.). U. S. Patent 3,596,714. 3 Aug 1971. Filed 14 Jun 1968.

Gaseous radioactivity in a chimney after stimulation of a gas reservoir with a nuclear explosive is reduced by injecting a heavy gas substantially free of unreacted oxygen into the lower portion of the chimney to displace the lighter, radioactive contaminated gas out of the upper portion of the chimney. Several ways are given for determining the minimum amount of heavy gas to be injected. The heavy gas may be backflowed from the chimney and uncontaminated natural gas may be injected into the upper portion of the chimney to displace the heavy gas from the lower portion of the chimney. Due to drilling difficulties, injection of gas into and production of gas from the chimney may be conducted through a single, dually completed well drilled alongside the chimney in the fractured zone immediately adjacent to the chimney. (Official Gazette)

4513 RECOMMENDATIONS FOR CRITICALITY SAFETY IN HANDLING AND PROCESSING FISSILE MATERIALS. PART 1. PRINCIPLES OF CRITICALITY SAFETY. BS 3598 Pt. 1 1963. London; British Standards Institution (1963). 5p. Available from American National Standards Institute, New York.

Standards are presented to provide a guide in the prevention of criticality accidents in all operations with fissionable materials outside the cores of nuclear reactors, but within the boundaries of nuclear establishments. These operations include the handling, processing, storage, transport, and treatment of fissionable materials. (L.C.L.)

4514 RECOMMENDATIONS FOR THE ASSESSMENT OF SURFACE MATERIALS FOR USE IN RADIOACTIVE AREAS. PART 1. METHOD OF TEST FOR EASE OF DECONTAMINATION. BS 4247 Pt. 1 1967. London; British Standards Institution (1967). 5p. Available from American National Standards Institute, New York.

A standard method is presented for testing surface materials to be used in radioactive areas for ease of decontamination. Information is provided on the test materials, preparation of test samples, contaminants, decontaminants, counting equipment, test procedures, and method for reporting results. (L.C.L.)

4515 BASIC TECHNICAL PRINCIPLES OF THE IAEO SAFETY CONTROL. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 8-9, 426-9 (Aug-Sep 1971). (In German).

The model plan for agreements between the IAEO and those countries that ratified the nuclear non-prolifertaion treaty provides that each country establishes its own monitoring system, the findings of which must be verified by the IAEO. The report of the IAEO control committee that forms the basis of the model plan also contains the technical principles for the verification system. The system treats the survey procedure from the standpoint of basic principles and practical execution, such as release of installation data, log books, submission of national reports, and IAEO inspections. (tr-auth)

4516 IMPROVEMENTS TO SEALING DEVICES FOR RADIOACTIVE CELLS AND SIMILAR ENCLOSURES. (to Robatel SLPI). French Patent 2,048,094. 8 Mar 1971. Filed 4 Jun 1969. (In French).

Sealing equipment is described which consists of two elastically deformable hollow lid shaped devices tightened against one another along their common periphery by means of a central tightening mechanism. The forcing together of these lids causes a radial deformation; the sealing is effected by a peripheral elastic sealing ring which presses against the inner walls of the opening to be sealed. The tightening mechanism may be of the screw or cam type, and is controlled by a wheel or lever. The operation may be performed manually, with an articulated mechanism, or using a telemanipulator. (France)

4517 RECOMMENDATIONS FOR THE ASSESSMENT OF SURFACE MATERIALS FOR USE IN RADIOACTIVE AREAS. PART 2. GUIDE TO THE SELECTION OF MATERIALS. BS 4247 Pt. 2 1969. London; British Standards Institution (1969). 7p. Available from American National Standards Institute, New York.

Recommendations are presented which provide a guide to assist in the selection of surface materials for use in areas likely to be subjected to radioactive contamination. These recommendations apply to surface materials which may be accidentally or deliberately contaminated with radioactive substances and from which the contaminant is required to be removed or to have its concentration reduced to an acceptable level. The surfaces involved include the floors, walls, ceilings, and working surfaces of radioactive areas. (L.C.L.)

4518 CHEMICAL FORMS OF AIRBORNE RADIOIODINE IN THE EXHAUST AIR FROM ^{131}I PRODUCTION PLANT. Tachikawa, Enzo; Naritomi, Mitsuo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 371-6 (Jul 1971).

Airborne radioiodine released from the reaction cell into the exhaust air during the processing operations at an ^{131}I production plant was analyzed by gas chromatography. The iodine compounds observed were $CH_3{}^{131}I$, $C_2H_5{}^{131}I$, $H^{131}IO_4$ and $H^{131}IO_3$. The distribution of the total ^{131}I among these compounds differs greatly according to the time of sampling after the start of processing. In the beginning, $H^{131}IO_3$ is highly predominant, but the content of organic iodides increases with progress of the processing operation. The removal efficiency of the charcoal filter installed in the stream of the exhaust air was better than 85% for the total ^{131}I but less than 50% when organic iodides alone were taken into account, indicating poorer efficiency of the filters for the latter compounds. The total amount of $CH_3{}^{131}I$ released was of mCi order. This suggests a very promising new method for obtaining $CH_3{}^{131}I$ as a by-product without any special chemical treatment. (auth)

4519 IONISING RADIATIONS: PRECAUTIONS FOR INDUSTRIAL USERS. New Series No. 13 1969. London; Her Majesty's Stationery Office (1969). 72p. Available from Pendragon House, Redwood City, Calif.

The risks associated with the precautions necessary in the industrial uses of x-ray machines and other apparatus which emit ionizing radiations and uses of sealed and unsealed radioactive substances are presented. The types of radiations concerned with are alpha particles, beta particles, gamma rays, x rays, bremsstrahlung, and neutrons. The most common industrial uses of ionizing radiations include: gamma and x-ray radiography; x-ray fluoroscopy; static elimination; density, level, and thickness gaging; package inspection; luminizing; and tracer work. Information is presented on principles of protection against external and internal radiation, international standards for radiation protection, safety requirements under the British Factories Act of 1961, and the equipment and methods for radiation protection associated with specific uses of radiation sources. (L.C.L.)

4520 INSTALLATION FOR COATING RADIOACTIVE SLURRIES. Andriot, Roger (to Commissariat a l'Energie Atomique). French Patent 2,052,093. 29 Mar 1971. Filed 15 Jul 1969. (In French).

An installation for coating radioactive slurries is described. The equipment involves a thin film evaporator, a means of extracting the vapor released in the evaporator, and a geared pump for extracting the coated slurries obtained at the bottom of the evaporator. (France)

4521 PROTECTION CASK. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). French Patent 2,050,952. 22 Mar 1971. Filed 30 Jun 1969. (In French).

A cask for storing and transporting radioactive solutions contained inside glass or plastic bottles is described. It consists of a thick-walled vessel which contains the bottle and is equipped with a lid and a transporting handle; two blocking nuts fix the position of this handle. (France)

4522 SOME SHIPMENTS OF IRRADIATED FUEL ELEMENTS IN ITALY. Com. Naz. Energ. Nucl., Notiz.; 17: No. 6, 98-104(Jun 1971). (In Italian).

A description is given of some shipments of irradiated fuel elements carried out in Italy by the Borghi Co., which for years has been operating in this field. (auth)

4523 LABELLING AND MARKING OF PACKAGES AND CONTAINERS FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. AECP 1030 Issue No. 2 1969. Risley, Eng.; United Kingdom Atomic Energy Authority (1969). 29p.

A Code of Practice is presented which amplifies the provisions embodied in various regulations and codes for the safe transport of radioactive materials, relating to the labeling of packages of such materials, and to provide detailed instructions that will ensure fulfillment of the relevant requirements. It was assumed that those using the Code will be familiar with the international and national transport regulations, which are based on the IAEA Regulations and that these users will have experience with transport procedures. Information is included on regulations for the labeling of inland (UK) and overseas postal packages and of packages transported by train or aircraft. (L.C.L.)

4524 PROVISION OF TRANSPORT PACKAGING FOR RADIOACTIVE MATERIALS. AECP 1042 Issue No. 1 1969. Risley, Eng.; United Kingdom Atomic Energy Authority (1969). 23p.

The safe transport of radioactive materials is governed by various regulations which are based on the "IAEA Regulations for the Safe Transport of Radioactive Materials, 1967 Edition." A supplement to the regulations is presented for the purpose of advising designers of packaging on the technical features necessary to conform to the regulations and of outlining the procedure for obtaining approval of packaging designs from the competent authority. Standards for the design, construction, and certification of industrial, Type A, and Type B packaging used in the UK for transporting radioactive materials other than irradiated fuel elements are described. (L.C.L.)

4525 LABELLING OF ROAD VEHICLES CARRYING RADIOACTIVE MATERIALS. AECP 1040 Issue No. 1 1968. Risley, Eng.; United Kingdom Atomic Energy Authority (1968). 5p.

A UKAEA Code is presented which gives guidance on the labeling requirements for vehicles carrying radioactive materials by road in Great Britain and on the continent of Europe. This code deals with exterior labeling of road vehicles in Great Britain and on the continent and the interior labeling of the vehicle cab. (L.C.L.)

4526 FISSILE MATERIAL TRANSPORT PACKAGING. PART I. REQUIREMENTS FOR TIMBER AND CADMIUM USED IN WOOD/CADMIUM SHIELDING. AECP 1023 Part 1 Issue No. 1 1965. Risley, Eng.; United Kingdom Atomic Energy Authority (1965). 6p.

Standards for timber and cadmium used in wood/cadmium shielding for packaging fissionable material are presented in two sections. The first covers the quality, determination of density, method of construction, and inspection of timber used for shielding in transport packaging for fissionable material. The second covers the purity and form of the metal, method of construction, corrosion prevention, and inspection for cadmium embodied as a neutron absorber in transport packaging for fissionable material. (L.C.L.)

4527 TECHNIQUES FOR REMOTE SAMPLING OF GASES. Parker, D. R.; Brewer, L. W. (Sandia Labs., Albuquerque, N. Mex.). Amer. Ind. Hyg. Ass. J.; 32: No. 7, 475-9(Jul 1971).

The two methods of analyzing atmospheric constituents in areas removed from the laboratory where it is not practical to maintain analytical personnel have been: to place instrumentation at the remote site and telemeter the results of the analysis by electrical signal to the central control point; or to collect the sample with remotely operated valves and transport the sample to a central laboratory for analysis. The latter method was selected as the most practical approach for sampling the gaseous environment inside the tunnels where underground nuclear tests had been conducted. By using as much as 6500 feet of small-diameter tubing and a specially adapted gas chromatograph, meaningful data have been obtained without exposing personnel to the inherent dangers of the tunnel. (auth)

4528 DECANTING DEVICE INTENDED PARTICULARLY FOR RADIOACTIVE LIQUIDS. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). French Patent 2,050,953. 22 Mar 1971. Filed 30 Jun 1969. (In French).

A device for transferring radioactive liquids is described. It consists of two casks; the first contains the solution to be transferred and the second receives the solution; the device incorporates a flexible connecting pipe, a suction pump, and a switch enabling the pump to be remotely controlled. (France)

4529 DEVICE FOR ILLUMINATING A HANDLING CELL. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). French Patent 2,053,394. 5 Apr 1971. Filed 3 Jul 1969. (In French).

A device for illuminating cells used for handling radioactive products is presented. It consists of a fixed tubular sheath

penetrating into the vessel, a supporting tube, a plug whose length is at least equal to the wall thickness, and a device for retaining the plug in the position of vessel closure. One end of the supporting tube is specially adapted to house the electric lamps, and the other end is provided with a plate thrusting against the outer wall of the vessel. The tube is longitudinally traversed by electric cables feeding the lamps. The device enables the lamps to be changed without suppressing the protection afforded by the vessel. (France)

4530 REMOTE-CONTROL DEVICE FOR OPENING IRRADIATED TUBULAR VESSELS. Auger, Jean-Pierre; Esnault, Michel; Guyon, Gabriel (to Commissariat a l'Energie Atomique). French Patent 2,051,916. 29 Mar 1971. Filed 1 Jul 1969. (In French).

Remote-control equipment for opening irradiated tubular vessels is described. It consists of a rotary device which accepts the vessel and rotates it about its axis, and a means of remotely controlling the movement of a cutting tool relative to this axis. A pneumatic device controls the rotation of the rotary equipment and the movement of the tool. (France)

4531 COMPRESSED AIR DEVICE FOR TRANSFERRING SAMPLES. Debrus, Jean; Pellerin, Achille; Ribot, Robert (to Commissariat a l'Energie Atomique). French Patent 2,041,479. 18 Jan 1971. Filed 25 Apr 1969. (In French).

A compressed air device is described for transferring radioactive samples into glove boxes which consists of two bushes, each consisting of a body which can be attached to a glove box and having three orifices. (France)

4532 USES OF LIQUID NITROGEN IN A PLUTONIUM HANDLING GLOVEBOX. Hirano, Kenmei; Takahashi, Akira; Tsujimura, Shigeo (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 10, 574-81 (Oct 1971). (In Japanese).

Changes of pressure in a plutonium handling glovebox containing liquid nitrogen were measured under various conditions. The conditions under which liquid nitrogen can safely be used were determined. It was concluded from the analysis of experimental results that the changes of pressure in the glovebox are proportional to the ratio (rate of evaporation of liquid nitrogen)/(rate of air flow through glovebox), and that a negative pressure can be maintained in reference to the atmosphere outside the glovebox as long as the volume of the glovebox is not too small and the amount of liquid nitrogen is within laboratory scale. The only exception is when a dewar vessel containing liquid nitrogen is upset in the glovebox, in which case a positive pressure is easily created in the glovebox. (auth)

4533 SHIPPING CONTAINERS (2 Feb 1971)(Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-2136).

29 drawings.

Neptunium, HAPO IB, HAPO II, and HAPO IC-1 shipping containers are described. The Np protective shipping packaging is used in shipping 30 to 35 liters of Np nitrate or up to 50 g of Np-237. The cask weighs ~446 lbs. A container liner and rack are also included. The liner and rack assembly accommodates nine one-gallon polyethylene bottles. The HAPO IB cask is used to ship up to 700,000 Ci of ^{144}Ce as dry $CeSO_4-Na_2SO_4$ or up to 500,000 Ci of ^{90}Sr as $SrCO_3$. A He atmosphere is used. The heat capacity is 34,000 BTU/hr. The system consists of a heavily shielded, finned cask surrounded by a protective buffer. The gross weight of the cask and buffer is 75,000 lbs. The tie-down system will keep the cask on the rail car under impacts of up to 30 mi/hr. Above this speed, the tie-down fails permitting the cask and buffer to leave the railcar. The HAPO II cask is used to ship up to 350,000 Ci of dry $SrCO_3$ cake in the filter cavity of the cask. The system consists of a heavily shielded vertically finned cask surrounded by a protective container (buffer). The same type of tie-down that is used in HAPO IB is employed. The weight of the system is ~37,000 lbs. Heat dissipation capacity is 11,600 BTU/hr. A He atmosphere in the filter unit aids in heat transfer. Cooling coils with external connectors are provided for unloading. A buffer, with four concentric vertical steel shells, surrounds the cask. The outer shell of the buffer fastens to the rail car deck. The HAPO IC-1 cask is a modification of the HAPO IB cask. The cask weighs ~20 tons and may be used to transport up to 400,000 Ci of ^{137}Cs. The system consists of the fission product container, cask, and cask cover. The ^{137}Cs is adsorbed by synthetic zeolite. Cooling coils are located on the inside and the outside. The case is an externally-finned lead-shielded cylinder. The cask cover supports the fission product container and has 9 in. of Pb shielding. The outer shell of the cask container is ridgidly mounted on a depressed-center rail car. (For details see TID-4100 Suppl. 67) (F.S.)

4534 CASKS FOR IRRADIATED FUEL: A LOOK AT THE CASK DESIGNERS' GUIDE. Langhaar, J. W. (Savannah River Lab., Aiken, S. C.). Nucl. Safety; 12: No. 6, 553-61(Nov-Dec 1971).

Shipping containers for radioactive materials in quantities and concentrations above some rather low limits are required by federal regulation to meet certain performance criteria under specified environmental conditions, including a hypothetical accident. The thickly shielded containers for irradiated fuel and other strong gamma emitters require rigorous design and analysis to assure retention of shielding and adequate heat removal. Much effort has been devoted during the past 10 years to designing casks to meet these requirements and to developing procedures to demonstrate compliance with the regulations. The emphasis has been primarily on lead-shielded casks, which have been commonly used in the United States because of a favorable balance between investment and operating cost. Under some conditions, the greater payload or smaller size of a uranium-shielded cask justifies the greater investment. Among the design considerations are heat removal, criticality, shielding, structural integrity under impact and fire conditions, thermal behavior in a fire, resistance to fracture at very low temperatures, and assurance of proper fabrication. These design considerations are discussed in detail in the Cask Designers' Guide, USAEC Report ORNL-NSIC-68, which also describes the methods of analysis, fabrication techniques, and testing procedures found acceptable. 58 references. (auth)

4535 VERSATILE CONTAINMENT BOXES (10 Jun 1971) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-2142).

30 drawings.

In order to take advantage of quantity production and to discontinue custom design for each new containment box, a unit may be assembled from an assortment of stainless steel components which are described. After use, the containment box may be disassembled and the individual components cleaned separately. A box assembled from used parts is, for all practical purposes, a new box. The basic unit is a simple stainless steel shell with a minimum of permanently attached fittings, and is designed for easy and thorough decontamination. There are standardized openings in all six faces of the box, to which an assortment of fittings and components may be quickly attached to configure the box for a special purpose. The system consists of the following components: front panel, service panel, back door, side openings, bottom openings, support stand, filters, β-γ shielding, and miscellaneous accessories. The front panel is a large door with hook-on hinges and eight gasket-compression latches. Any configuration of glove ports may be dropped into place as needed. Service panels are rectangular openings provided for the top and back of the box. The openings are filled with $\frac{1}{4}$ in. thick panels of plastic or glass held in place with a zip-in neoprene gasket. In most of the boxes, a back door is provided which is similar to, but smaller than, the front panel. This usually carries a glove port for access to the back of the apparatus in the box. Molded-glass reinforced polycarbonate adapters are used for coupling the boxes together. A separate accessory (usually a sliding door) is fastened to the inside of the adapter ring. Two $7\frac{3}{4}$ in. dia precision openings are provided on the bottom. The forward left-hand opening is primarily for a canned clinical centrifuge, and the right-hand opening is used for waste disposal. In using the containment box for α work, a cart of $1\frac{1}{4}$ in. tubing is provided to support the box. Leg extensions are used to raise the assembly from a position suitable for a seated operator to that suitable for a standing operator. Two absolute filters are clamped to the top of the box. When used as a glove box, one $\frac{3}{4}$ filter serves as an air intake and the other is connected to an air exhaust system. When used with an open port, both filters are connected to the exhaust system. When radiation shielding for the operator is required, the box is placed on a 4 in. Pb slab, and a 3 in. Pb slab containing a Pb-glass window is erected in front of the box. (For details see TID-4100 Suppl. 67) (F.S.)

Vacuum Engineering

Refer also to abstract 4612.

4536 METHOD OF OPERATING AN ION-GETTER VACUUM PUMP WITH GUN AND GRID STRUCTURE ARRANGED FOR OPTIMUM IONIZATION AND SUBLIMATION. Rabinowitz, Mario; Garwin, Edward L. (to United States Atomic Energy Commission). U. S. Patent 3,588,593. 28 Jun 1971. Filed 27 Mar 1969.

Electrons injected between a cylindrical housing and a coaxial cylindrical grid at a predetermined angular momentum spiral over

long paths around the grid for optimum ionization of gas molecules. A first electrostatic field is established between the housing and grid for accelerating ions to the housing and for establishing an optimum kinetic energy of the orbiting electrons. A second electrostatic field is independently established between the grid and a concentric titanium rod anode at an optimum intensity for accelerating spent electrons through the grid to bombard and sublimate the titanium for burying ions and combine with active gases. (Official Gazette)

4537 ULTRAHIGH-VACUUM VALVE WITH AN INDIUM SEAL. Dvoichenko, V. D.; Vzatskaya, E. I. (Inst. of Radio Engineering and Electronics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 549-50(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 190-1(Mar-Apr 1971).

The construction of a valve with an indium seal in a passage cross section of 145 mm for a vacuum of 10^{-10} torr and higher is described. The valve does not leak at atmospheric pressure from either the outside or inside of the gate mechanism. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 4415.

General Detectors and Monitors

Refer also to abstracts 4647, 4756, 4761, 4768, 4795, 4807, 5902, 6383, and 6386.

4538 (CEA-N-1493) H.I.B. DIGITAL RATEMETER. Fuks, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 24 May 1971. 43p. (In French). Dep. NTIS (U. S. Sales Only).

An H.I.B. digital ratemeter is described including the ratemeter module, converter module, alarm–trigger module, power supply, and connection to the distribution system. The main characteristics of the apparatus and the specifications of the various components are given. (France)

4539 (NYO-4202-1) CADMIUM TELLURIDE DETECTORS. Interim Technical Report, June 1, 1970–May 31, 1971. Wald, F.; Bell, R. O.; Menna, A. A. (Tyco Labs., Inc., Waltham, Mass.). Jul 1971. Contract AT(30-1)-4202. 102p. Dep. NTIS.

Topics discussed include the following: (1) procedures for the reproducible synthesis and purification of CdTe are described. As a final step, solution purification using Te zones and RF heating is used. (2) Detailed analyses of THM growth of CdTe and attendant experimental results are given and the resulting furnace construction parameters are outlined. (3) Measurements on nuclear detectors are reported and limitations on γ-spectra are discussed. Material requirements are outlined and it is shown that besides high purity the compensation of native defect generated carriers is the major problem. A new model of In compensation in CdTe is presented which is felt to be useful in dealing with the native defect problem. (auth)

4540 (ORNL-TM-3631) SOME TESTS RELATED TO THE USE OF PROTON RECOIL PROPORTIONAL COUNTERS FOR NEUTRON-FLUX MEASUREMENTS. Straker, E. A.; Love, T. A.; Burgart, C. E.; Freestone, R. M. Jr.; Morgan, G. L. (Oak Ridge National Lab., Tenn.). 16 Nov 1971. Contract W-7405-eng-26. 18p. Dep. NTIS.

Several tests have been made in order to check the accuracy of neutron-flux measurements obtained with a spherical hydrogen-filled proportional proton-recoil counter. The results indicate such measurements are valid for neutron energies as low as 10 keV. (auth)

4541 RESPONSE OF ACTIVATED THALLIUM CHLORIDE AS A SCINTILLATION SPECTROMETER FOR HIGH ENERGY ELECTRONS. Ford, R. L.; Hofstadter, R.; Hughes, E. B.; O'Neill, L. H.; Schilling, R. F. (Stanford Univ., Calif.). Rev. Sci. Instrum.; 42: No. 11, 1727-8(Nov 1971).

The response of a cylindrically-shaped TlCl (Be,I) crystal, 7.6 cm long and 8.36 cm in diameter, to electrons in the range from 100 to 1000 MeV is reported. (W.H.K.)

4542 CHANNEL ELECTRON MULTIPLIER EFFICIENCY FOR PROTONS OF 0.2 TO 10 keV. Iglesias, G. E.; McGarity, J. O. (Rice Univ., Houston, Tex.). Rev. Sci. Instrum.; 42: No. 11, 1728-9(Nov 1971).

Initial results of measurements of the absolute proton efficiency of Bendix type 4013 Channeltrons are presented. (W.H.K.)

4543 CHANNEL ELECTRON MULTIPLIER OPERATION IN THE CONTINUOUS CURRENT MODE. Rowe, J. E.; Christman, S. B.; Plummer, R. D. (Bell Telephone Labs., Inc., Murray Hill, N. J. Rev. Sci. Instrum.; 42: No. 11, 1733-4 (Nov 1971).

The possibility of using the channel electron multiplier in the analog continuous current mode is pointed out. By combining this mode with the usual pulse counting mode, one can extend the dynamic range of the channel multiplier over several decades. (auth)

4544 MULTI-WIRE PROPORTIONAL CHAMBERS FOR LOW DOSE X-RADIOGRAPHY. Kaufman, Leon; Perez Mendez, Victor; Sperinde, John; Stoker, Gerald (Univ. of California, San Francisco. Univ. of California, Berkeley). Contract W-7405-Eng-48. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 113: No. 2, 378 84(Oct 1971).

The design and performance of xenon-filled multiwire proportional chambers for x radiography are described. The spatial resolution was of the order of 1 mm and the detection efficiency varied between 97 and 2.5 per cent in the x-ray energy range from 5 to 100 keV. (W.H.K.)

4545 GAS RADIOLYSIS IN AN ELECTRIC FIELD. III. NUMERICAL SOLUTION FOR THE CURRENT-VOLTAGE CHARACTERISTIC AND EFFECT OF THE FIELD ON THE AVERAGE ION CONCENTRATION IN THE IONIZATION CHAMBER. Karachevtsev, G. V.; Kogan, A. M.; Larin, I. K.; Mostovaya, E. M.; Tal'roze, V. L. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 3, 277-8(May-Jun 1970). (In Russian).

Full copy of this paper is held by DTIE.

An approximate solution was previously found for the effects of an electric field on the average ion concentration in an ionization chamber. It was shown that, depending primarily on the ion mobilities, the electric field might either decrease or increase the ion concentration, and thus have different effects on the rates of ion-molecular reactions. A numerical solution for air and hydrogen (at 0°C and 1 atm) is reported. (W.H.K.)

4546 MEASURING OF EXPOSURES WITH CONDENSER IONIZATION CHAMBERS BY A COMPENSATION METHOD. Klumpar, J.; Majerova, M.; Ulicny, J. (Inst. of Nuclear Research, Prague). Radioisotopy; 11: No. 6, 1119-27(1970). (In Czech).

The description of a measuring device for condenser ionization chambers is given, where the results of only one measurement is directly expressed in Coulombs per roentgen and is independent of the sensitivity of the electrometer, serving only as a zero instrument. The precision of the estimation of exposures is not limited by the possible error of the determination of the electrical charges, but by effects given by disconnecting the condenser chambers from the measuring device. (auth)

4547 EFFECTIVE AREA OF A COLLIMATOR FOR GAMMA RAYS. Klumpar, J.; Jirousek, P. (Inst. of Nuclear Research, Prague). Radioisotopy; 11: No. 6, 1101-18(1970). (In Czech).

Equations are derived for the determination of correcting factors accounting for the partial penetration of the radiation through the edge of the collimator, to be used when standardizing energetic gamma rays by a free air ionization chamber. (auth)

4548 ELECTROMETERS FOR STANDARD IONIZATION CHAMBERS. Oppelt, J. (Czechoslovakian Meteorological Inst., Prague). Radioisotopy; 11: No. 6, 1053-1100(1970). (In German).

For the development of standard devices in the field of ionizing radiation, the properties of electrometers are discussed which are required for obtaining an accuracy of a few promille. Special attention is given to load measurement and to the influence of the parasitic capacity of the collector system. (auth)

4549 USE OF LIQUID SCINTILLATORS AS DETECTORS WITH A GASEOUS CAPTURE EMITTER, ^{37}Ar. Iorgulescu, Adriana (Institutul de Fizica Atomica, Bucharest). Compt. Rend., Ser. B: 273: No. 6, 278-81(9 Aug 1971). (In French).

It was demonstrated that liquid scintillators can be used for measurements with a gaseous emitter, ^{37}Ar. Similar experiments can be performed with other radioactive gases. The results obtained extend the applications of liquid scintillators into the domain of low energies. (France)

4550 Ge(Li) SEMICONDUCTOR PROBE FOR RADIOPROSPECTING. Dumesnil, P. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Instrum. Nucl.; No. 43, 31-3(Mar 1971). (In French).

A geological probe, which uses a semiconductor detector Ge(Li), is described. This probe allows direct determinations of the uranium content of ores to be made from measurements of the 235 isotope activity. (France)

4551 THIN ^{6}Li(n,α)T TRANSMISSION FLUX MONITOR. Macklin, R. L. (Oak Ridge National Lab., Tenn.); Hill, N. W.; Allen, B. J. Nucl. Instrum. Methods; 96: No. 4, 509-13(1971).

A thin glass scintillator system has been developed for fast time-of-flight neutron monitoring at the ORELA electron linear accelerator. Beam backgrounds under 1% from 6 to 100 keV, negligible environmental background, beam flash recovery in 1.25 μs, and a time resolution of less than 2 ns have been achieved on a 40 m flight path. The monitor can be used in transmission,

on-line introducing additional dips of less than 4% in the transmitted neutron spectrum at 55, 200, 240, 440 keV and higher from the constituents of the glass scintillator. (auth)

4552 SHELLED ACTIVATION DETECTORS FOR THE MEASUREMENT OF NEUTRON SPECTRA ESPECIALLY AT KILOVOLT ENERGIES. Henninger, R. J.; Amster, H.; Binney, S. E.; Mark, H. (Univ. of California, Berkeley); Nucl. Instrum. Methods; 96: No. 4, 515-24(1971).

A "shelled activation detector (SAD)" is a neutron measuring instrument consisting of a small, spherical, cadmium-covered resonance-absorbing core surrounded by a concentric thick shell of polyethylene and, in some cases, by an outer layer of boron. The rate at which the core absorbs neutrons is determined later from its induced radioactivity. How a measurement by any spherically symmetric detector is related to the scalar flux that would have been at its center if it were absent is derived for an arbitrarily anisotropic angular flux. The absorption rate, as a function of the energy of neutrons entering the SAD, has a single maximum at an energy that depends on the dimensions of the SAD regions. Such response functions, obtained from the "adjoint flux" calculated by the one-dimensional, multigroup, transport code ANISN, were used to design a set of SAD's for the kilovolt energy range. Some experiments with nearly monoenergetic photoneutrons were compared with the calculations. (auth)

4553 MEASUREMENTS AND CALCULATIONS OF NEUTRON DETECTOR EFFICIENCIES. Thornton, S. T.; Smith, J. R. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 96: No. 4, 551-5(1971).

Neutron detector absolute efficiencies measured for several organic scintillators are reported. A substantially revised version of Kurz's neutron detector efficiency computer program has been used to calculate efficiencies for new and previous measurements. Good agreement has been obtained for various scintillators. (auth)

4554 FULL-ENERGY PEAK EFFICIENCY CALIBRATION OF A WELL-TYPE Ge(Li) GAMMA-RAY DETECTOR. Verplanke, J. C. (Philips Research Labs., Eindhoven, Netherlands). Nucl. Instrum. Methods; 96: No. 4, 557-60(1971).

Calibrations were carried out with reference standard solutions of eleven different nuclides covering the energy range from 60 keV to 1836 keV. In order to cover that range gamma-cascade-emitting nuclides had to be used and, consequently, corrections for summing effects had to be made. (auth)

4555 CHARACTERIZATION OF HIGH RESISTIVITY CdTe FOR γ-RAY DETECTORS. Canali, C. (Univ., Modena, Italy); Martini, M.; Ottaviani, G.; Alberigi Quaranta, A.; Zanio, K. R. Nucl. Instrum. Methods; 96: No. 4, 561-71(1971).

An extensive investigation on semi-insulating CdTe for use in radiation detectors is presented. Transient techniques are used to measure the carrier drift mobilities and trapping times, the plasma time, and the activation energies, cross sections and densities of traps. A shallow electron trap with a density of 10^{17} cm^{-3}, an activation energy of 0.05 ± 0.01 eV, and a cross section of 10^{-16} cm^2 was identified. The electron trapping time increases by over an order of magnitude with increasing electric field. The plasma time for 5.48 MeV alpha particles ranged from 100 nsec at an electric field of 500 V/cm to 4 nsec at an electric field of 10 kV/cm. With 5.0 MeV alpha particles from an accelerator, a room temperature resolution of 0.58% (fwhm) was obtained. (auth)

4556 HOT CARRIERS IN Si AND Ge RADIATION DETECTORS. Drummond, W. E.; Moll, J. L. (Stanford Univ., Calif.). J. Appl. Phys.; 42: No. 13, 5556-62(Dec 1971).

Characteristics of silicon and germanium radiation detectors are developed from an analysis of the energy-loss mechanisms for hot carriers. The carrier behavior is described in terms of phonon and ionization scattering rates. A calculation of the probability of ionization vs primary electron energy in silicon, using Kane's characterization of the scattering rates, indicates an effective ionization threshold several times the band-gap energy. Calculations of phonon losses and the carriers' residual kinetic energies are combined to give an average energy expended per created pair ϵ of 4.24 eV. Closer agreement with the experimental value of 3.67 eV is achieved by lowering the phonon to ionization scattering-rate ratio. Temperature effects, which enter through changes in the band gap, are calculated to be $\partial\epsilon/\partial E_g = 1.73$. The analysis also predicts a Fano factor of 0.059 for silicon. Discussion of the germanium situation is based on the premise of hot-carrier behavior similar to that in silicon. Because germanium has a more complicated band structure, two sets of calculations are made using different effective band gaps. With $\epsilon = 2.96$ eV at 90°K, very similar results are obtained in both cases and indicate $\partial\epsilon/\partial E_g \approx 1.77$ and $F \approx 0.066$. (auth)

4557 CALCULATION OF THE ESCAPE PEAK FOR Ge–Li AND NaI RADIATION DETECTORS. Fioratti, M. P.; Piermattei, S. R. (CNEN, Rome). Nucl. Instrum. Methods; 96: No. 4, 605-8(1971).

The ratio of the escape peak to photopeak photons for Ge–Li detectors is reported. The theoretical results are compared with those evaluated experimentally by other authors and the agreement is rather satisfactory. The same calculations have been reported for a NaI detector and compared with those obtained by measurements. (auth)

4558 AMBIENT RADIOACTIVITY WARNING DEVICE. Vincent, Michel; Crespi, Gerard (to Laboratoire Central de l'Armement). French Patent 2,053,682. 5 Apr 1971. Filed 15 Jul 1969. (In French).

A device for monitoring the ambient radioactivity is presented. An optical or acoustic signal is delivered when the level of radioactivity (especially γ radioactivity) exceeds a predetermined threshold. The device, which is transistorized, has a very precise warning threshold, and will record over the entire range of γ radioactivity levels. It is light, portable, and simple to use, and widespread applications are foreseen. (France)

4559 PROCESS FOR THE DETECTION AND MEASUREMENT OF IONIZING RADIATION BY THE USE OF RADIATION-DEGRADABLE MATERIAL. Goulin, Jean-Paul Lucien (to Eastman Kodak Co.). U. S. Patent 3,604,929. 14 Sep 1971. Priority date 5 Mar 1968, France.

Radiation-degradeable film, a portion of which has been irradiated, is treated initially with a basic solution, containing a chemical reagent which swells the material constituting the film, making it possible for the basic solution to attack the radiation degraded parts more deeply. Also, in a further operation the film may be treated with a solvent which dissolves surface roughness formed during the initial treatment so that the non-degraded parts recover their initial transparency while the more deeply attacked degraded parts remain visible. This method lends itself to automatic dosimetry in which the optical densities of irradiated and nonirradiated portions of the material are compared. (auth)

4560 DIELECTRIC TRACK DETECTORS. ALPHA PARTICLE DETECTION USING CELLULOSE NITRATE. Anno, J.; Commanay, L. (Univ., Toulouse). Ann. Phys. Biol. Med.; 5: No. 2, 65-78(1971). (In French).

The formation of alpha particle tracks in cellulose nitrate films, the developing technics and the counting of the tracks were studied. It was found that to form a track, particles must have an incident angle smaller than 65 deg. The recording efficiency of the detector was 90 percent. It was also found that the statistical counting error decreases with the density of the tracks and was equal to 5 percent for a total of 2000 tracks. (France)

4561 DETECTION DEVICE FOR LOCALIZING RADIATIONS. Allemand, Robert; Brey, Christian; Jacobe, Jean (to Commissariat a l'Energie Atomique). French Patent 2,054,433. 23 Apr 1971. Filed 23 May 1969. (In French).

A device for detecting electromagnetic radiations (x or γ), or charged particles (β radiation) is described. This device enables the spatial distribution of a beam of radiation to be determined, it provides simultaneous information about the whole of the space examined. It consists of a number of cells distributed evenly in a gas filled sealed enclosure. Each cell possesses a filament anode, two semi-cathodes, and a means of obtaining the electrical impulse signals from these semi-cathodes. The two electrical impulse signals are applied to a localization device, which associates each cell, in a one-to-one correspondence, with the two signal channels. A continuous potential difference is applied between the anode and the two semi-cathodes. The assembly operates in the proportional region. (France)

4562 SIGNALLING MEMBER AND METHOD FOR PROGRAMMING AUTOMATIC RADIOACTIVITY-MEASURING SYSTEM. Nather, Roy E. (to Beckman Instruments, Inc.). U. S. Patent 3,604,935. 14 Sep 1971. Filed 1 Apr 1969.

The apparatus and method for coding commands on a pseudo-sample signaling member (control tower) which may be sensed and used to alter the program of an automatic liquid scintillation radioactivity measuring system are described. The signaling

member is placed in the sample conveyor. It may also direct functions such as group reject. (auth)

4563 CARRIAGE APPARATUS FOR SCANNING MEANS. Leiter, Harry. U. S. Patent 3,606,798. 21 Sep 1971. Filed 20 Jun 1968.

Means for recording data corresponding to the distribution and concentration of radioactive sources detected over a scanning region together with means for converting said recorded data into a visual display at any desired time and as often as may be required are described. A scintillation detector is mounted for linear movement in opposite directions along a carriage which is itself mounted for linear movement in opposite directions orthogonal to the directions of movement of the scintillation detector, the carriage being actuated to move the detector to the next adjacent scanning line during the reversal of scanning direction. Output signals from the detector are routed to signal processing means, and after processing, data are recorded on one track of a magnetic tape while control signals generated at the end of each scan are recorded on another track of the magnetic tape. The readout apparatus may include an intensity modulated light source secured on a carriage for rectilinear movement in opposite directions at a constant speed to cause the modulated light beam to traverse an underlying photographic film, while the carriage itself is also shiftable in a direction along a line orthogonal to the scanning motion of the light source so that movements of the light source may duplicate those of the radiation detector scanning device. The recorded signal may be adjusted to provide an output for producing the required exposure of the film avoiding a new scanning operation over the radiation source for obtaining adjustments in the exposure to provide the required information in a photographic record or in the display of the information on a cathode ray tube face. (auth)

4564 LIQUID SCINTILLATION COUNTING. METHODS OF INTRODUCING RADIOACTIVE SAMPLES INTO SCINTILLATING SOLUTIONS. Laine-Boszormenyi, M.; Fallot, P. (CEN de Saclay, Gif-sur-Yvette, France). J. Biol. Med. Nucl.; 6: No. 24, 14-19(1971). (In French).

The principles involved, the advantages, and the disadvantages of scintillation counting in liquid media, are briefly discussed. The introduction of radioactive samples into the scintillating solution is one of the inherent difficulties encountered. Several examples in biology are used to demonstrate the general principles adopted in overcoming this problem. (France)

4565 INCREASED EFFICIENCY OF GAMMA RAY RECORDING BY DIFFERENTIAL IONIZATION CHAMBERS. Gol'din, M. L.; Tamarov, I. S.; Neifeld, N. I. (Karkov Inst. of Mechanization and Electrification of Agriculture). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 131-3(1971). (In Russian).

Interconnected differential ionization chambers are widely used for the resolution of special problems in nuclear and applied physics, in spite of their poor efficiency, generally under 4%. Their efficiency may be boosted by filling the chamber with inert gas or by raising the pressure of the contained gas. Volt-ampere characteristics of ionization chambers show that filling a chamber with a Kr–Xe mixture increases the ionization current by a factor of 3.2 over that of the same chamber filled with air. The procedure for drying and filling chambers is described. (K.S.W.)

4566 PROTON SPECTROMETER WITH AUTOMATIC FOLLOW-UP OF THE DISTRIBUTION MAXIMUM. Zhurina, L. S.; Ol'dekop, L. G.; Polenov, V. V.; Khazanov, B. I. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 380-2(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 46-8(Mar-Apr 1971).

The design principle for a low-energy proton spectrometer having three electrostatic analyzers and a system for automatic follow-up of the maximum energy distribution of the particles is described. The instrument allows the minimum of information to be transmitted which completely characterizes the energy distribution; this reduces the measurement time and increases the reliability of the results obtained. (auth)

4567 MULTIDIMENSIONAL ANALYSIS OF THE DIFFERENTIAL CROSS SECTION OF THE (n,n′γ) REACTION INVOLVING PURE ISOTOPES. Andreev, E. A.; Sit'ko, S. P.; Shevchenko, V. A. (Kiev State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 373-6(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2 40-3(Mar-Apr 1971).

A unit for the multidimensional analysis of the differential cross section of the (n,n′γ)-reaction is described. The multidimensional analysis (six pickups) allows a substantial reduction in measurement time. The equipment complex which has been developed contains a multidimensional amplitude analyzer with a nonintegrating memory using paper tape, a system of shapers, preamplifiers, gates, mixers, fast-coincidence circuits, and discriminators. The final check of the operation of all the sections of the unit showed the possibility of obtaining the angular distribution of γ rays from the (n,n′γ) reaction involving samples weighing several grams during 200 h of measurement time. (auth)

4568 UNIT FOR HIGH-SPEED INSPECTION OF PLATES WITH A NUCLEAR EMULSION. Zav'yalov, A. P.; Markov, V. N.; Rogunov, L. M. (Inst. of Biophysics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 422-3(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 82-3(Mar-Apr 1971).

An automatic unit which allows preliminary determination of the localization of the tracks with α- and β-active "hot" particles on plates with a nuclear emulsion is described. In 8 h of operation one can expect and record the particle tracks of three plates having a size 9 × 12 cm or six plates having a size 6 × 9 cm. (auth)

4569 TIME-COORDINATE COMPENSATOR FOR TIME SPECTROMETERS WITH LONG SCINTILLATORS. Ondrish, L.; Mukhin, S. V.; Rikhvitskii, S. V.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 454-6(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 110-12(Mar-Apr 1971).

The circuit of a time-coordinate compensator for time spectrometers operating from long plastic scintillators with two photomultipliers (p.m.) at their ends is described. The amplitude of the negative input pulses is not less than 0.3 V, while the amplitude of the output pulses is not less than 1 V across 50 Ω, with a length of 15 nsec. The time fluctuations of the output pulses of the compensator are less than ±50 psec when the spot at which a scintillator 50 cm long is illuminated by a light-emitting diode varies. (auth)

4570 CALCULATION OF THE EFFICIENCY OF RECORDING GAMMA-RADIATION FROM POINT ISOTROPIC SOURCES BY MEANS OF NaI(Tl) CRYSTALS. Konstantinov, I. E.; Moiseev, I. F.; Slavyagin, P. D.; Fedorov, G. A. (Moscow Engineering-Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 433-8(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 91-6(Mar-Apr 1971).

Results are given of calculations of the efficiency of recording γ radiation from point isotropic sources having energies of 27, 139, 324, 364, 662, 1250, and 1460 keV by means of the NaI(Tl) crystals having the dimensions 20 × 20, 40 × 40, 70 × 50, 120 × 120, 140 × 100 mm (diameter × height) for a spacing of 20 to 180 cm between the geometric center of the crystal and the source and angles from 0 to 80° between the crystal axis and the ray from the "geometric center of the crystal to the source." (auth)

4571 EFFECT OF ADMIXTURES ON THE TEMPERATURE INSTABILITY OF LIQUID SCINTILLATORS. Zhil'tsova, L. Ya.; Zemskova, I. I.; Matveeva, E. N.; Tyminskii, V. G. (All-Union Scientific-Research Inst. on Normalization in Machine Design, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 439-40(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 97-8(Mar-Apr 1971)

Experimental data are given on the investigation of the light yield of a liquid scintillator prepared using a vaseline-oil base when it is heated in the presence of various antioxidant admixtures. It is shown that temperature stability of such systems may be increased by introducing special additives. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 6377.

4572 (CEA-N-1432) SEMI-FAST PROPORTIONAL AMPLIFIER (MAP 16). Petin, Andre; Rogerieux, Marcellin; de Rosny, Gerard; Sarles, Jean-Claude (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 27p. (In French). Dep. NTIS (U. S. Sales Only).

The structure of a semi-fast proportional amplifier intended for a gamma spectrometry unit is described and some measurements are presented. The structure adopted has a rise time of less than 30 ns, which remains fairly constant with increasing gain. Considerable importance was attached to reducing the thermal drifts in the gain and continuous level and reducing the relative input noise. The thermal drifts were reduced to 5.10^{-5} °C for the gain, and 8 μV °C for the relative input continuous level.

The relative input noise was 1.35 μV_{eff} with one differentiation with a 3 μs time constant and two integrations with 3 μs time constants. (France)

4573 (NP-19003) ABSOLUTE DETERMINATION OF SOME α-PARTICLE ENERGIES. Grennberg, Bertil (Uppsala Univ. (Sweden)). 1971. 4p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A review is given of work undertaken in order to increase the number of reference points for alpha spectroscopy. It is established that due to the installations at the International Bureau of Weights and Measurements it is possible to increase the maximum accuracy of measurements by a factor of five in relation to that initially foreseen. (J.F.P.)

4574 MINIATURE VACUUM FURNACE FOR MOESSBAUER SPECTROSCOPY. Sundaram, V. S.; Gupta, V. P.; Subbarao, E. C. (Indian Inst. of Tech., Kanpur). Rev. Sci. Instrum.; 42: No. 11, 1616-18(Nov 1971).

The complete geometry and operation of a simple miniature furnace designed for heating the sample up to 1000°C for Moessbauer spectroscopy are reported. Cooling coils over the entire body of the furnace protect the source and counter from heating. Maintenance of constant temperature (±1°C) for several hours, temperature uniformity (±1°C) across the sample, and flexible use of vacuum, ambient, or inert atmosphere constitute the special features. (auth)

4575 ELECTRIC SCHEME FOR DRIVING AND STABILIZING AN IRON BETA SPECTROMETER WITH TWO MAGNETIC LENSES. Ringhiopol, I. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 7, 763-71(1971). (In Rumanian).

An electronic system for simultaneously driving and stabilizing the field produced by two magnetic lenses and by an electromagnet for a beta spectrometer is described. (W.H.K.)

4576 SPECTROMETER FOR α RADIATIONS. Blondel, Maurice (to Commissariat a l'Energie Atomique). French Patent 2,044,153. 8 Feb 1971. Filed 9 May 1969. (In French).

An α particle radiation spectrometer is described. The source and the detector are contained inside a sealed bell shaped enclosure, which is connected to a vacuum pump; a detector and a cooling cryostat are incorporated. A source holder platform is rigidly connected to a disc diaphragm holder, and a screen with a single aperture lying along the detector axis. These components are mounted on a sliding rotating spindle which passes through the adjustable base of the bell shaped enclosure. The axial separation between the source, the diaphragm, and screen from the detector is regulated from the exterior. The enclosure may be used as a storage chamber and as a spectrometer. The introduction of sources or diaphragms does not disturb the vacuum. (France)

4577 MERCURY IODIDE AS A GAMMA SPECTROMETER. Willig, W. R. (Siemens Research Labs., Erlangen, Ger.). Nucl. Instrum. Methods; 96: No. 4, 615-16(1971).

Single crystals of semi-insulating mercury iodide, grown from an organic solution or by vapour transport, used as gamma spectrometers, had an energy resolution of about 10%. (auth)

4578 UNIVERSAL GAMMA-RESONANCE SPECTROMETER. Dolenkc, A. V.; Egiazarov, B. G.; Shamov, A. I. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 377-9(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 43-6(Mar-Apr 1971).

A Moessbauer spectrometer with several operating modes is described. Besides the conventional constant-velocity and constant-acceleration mode, a trapezoidal mode is available with a specific sector of the spectrum cut out, as well as a mode with registration of zero velocity. A new vibrator construction without springs is used. Elimination of the drift of position and zero velocity is achieved by a photodiode commutation circuit. The operation of the spectrometer is completely automated in all operating modes. The basic spectrometer parameters are: velocity resolution 0.01 mm/sec, linearity 0.2%, velocity range 0 to 50 cm/sec, and loading of the γ-quantum recording channel 10^5 pulses/sec. (auth)

4579 CERTAIN POSSIBILITIES OF THE APPLICATION OF THE TWO-DIMENSIONAL ANALYSIS MODE IN NEUTRON SPECTROMETRY. Omel'yanenko, A. A.; Stoletova, I. M.; Matveeva, E. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 392-6(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 56-60(Mar-Apr 1971).

This article describes equipment used in the AI-4096-2 multichannel analyzer operating in a two-dimensional analysis mode for separation of neutrons and γ quanta according to the shape of the scintillation pulse and gives results of the investigation of the separating properties of a number of liquid scintillators for low-energy particles. The effect of the technology of fabricating the scintillators on their separation properties is shown. A scintillator having properties close to those of the NE321 has been constructed using Soviet-produced materials. When trimethylborate is added, this scintillator may be used to separate slow neutrons and γ quanta. (auth)

4580 FAST-NEUTRON TIME-OF-FLIGHT SPECTROMETER. Gurtovoi, M. E.; Kukhlenko, A. S.; Leshchenko, B. E.; Pete, G.; Strizhak, V. I. (Kiev State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 390-1(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 54-5(Mar-Apr 1971).

A fast-neutron spectrometer using the time-of-flight method was designed and fabricated. The time resolution of the spectrometer is at worst 3 nsec. For a time-of-flight base of 10 m and neutrons having an energy of 15 MeV the energy resolution is ~3% (~450 keV). The dynamic range of the spectrometer is from 5 to 15 MeV. The spectrum of neutrons scattered by iron is given. (auth)

4581 SEMIAUTOMATIC DEVICE FOR MEASURING THE ENERGY RESOLUTION OF SPECTROMETERS. Selyutin, V. P.; Fedovseeva, O. P.; Finogenov, K. G. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 457-8(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 112-14(Mar-Apr 1971).

The method and practical device serving to measure the width and position of the pulse amplitude distribution peak obtained at the output of a spectrometric amplifier are described. The method makes it possible to carry out measurements rapidly with fair accuracy. The error accompanying the noise measurement does not exceed 3% when a resolution of 10% of the measured quantity is measured. The measurement time is 5 to 15 sec. The measurements were carried out on a semiconductor α spectrometer. (auth)

4582 AMPLIFIER FOR PRECISE SPECTROMETRY UNDER LARGE LOADS. Ofengenden, R. G.; Ostapenko, A. A. (Inst. of Nuclear Research, Kiev). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 459-61(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 114-17(Mar-Apr 1971).

A simple spectrometric amplifier having the transient response of a CR-CR filter designed from directly coupled sections with differential input stages is described. The arrangement of the differentiating element in the negative feedback circuit of the first amplifier section allowed a low level of low-frequency pulsations to be obtained at the amplifier output while retaining high overload capacity; it likewise permitted the entire amplifier channel to be encompassed with dc feedback for null-level stabilization. Compensation of the pole introduced by the differentiating filter of the preamplifier is provided for, as well as suppression of phased noise. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 5709, 5760, 5920, and 5962.

4583 (LUSY-7008) CALIBRATION OF A LEAD-GLASS CERENKOV COUNTER. Jariskog, G.; Larsson, C. (Lund Univ. (Sweden). Dept. of Physics). Sep 1970. 11p. Dep. NTIS (U. S. Sales Only).

A lead-glass Cerenkov counter has been calibrated using monoenergetic electrons. The linearity of response, energy dependence of the resolution and directional properties are investigated. (auth) (Sweden)

4584 SHIFT REGISTER READOUT FOR WIRE SPARK CHAMBERS. Nunamaker, Thomas A. (Univ. of Chicago). Rev. Sci. Instrum.; 42, No. 11, 1701-4(Nov 1971).

Spark information is read out by means of integrated circuit shift registers placed directly on the spark chamber. This information is held on individual wire capacitors until the electrical pulsing noise has subsided, at which time it is parallel loaded into the shift register. Subsequently this information is serially transferred out at the user's convenience. The advantage of this system over other capacity readout systems is fewer components and interconnections, simplified cabling and readout, and lower cost. A 1024-wire system has been tested at the Chicago Cyclotron; these tests (2×10^6 individual sparks) indicate that the circuits hold up very well. Spatial resolution at 1 mm wire spacing is 1 mm

FWHM, and the efficiency is 99%. The average number of adjacent wires read out at full efficiency is 4.5. (auth)

4585 APPARATUS AND METHODS USED IN OBTAINING INFORMATION FROM PHOTOGRAPHIC TRACKS. Ginestet, Jean; Calmels, Christian (to Commissariat a l'Energie Atomique). French Patent 2,049,018. 26 Mar 1971. Filed 29 Apr 1969. (In French).

The apparatus and the methods used to obtain measurements and information from photographic tracks are described. A particular application is photographs made with bubble chamber type apparatus. (France)

4586 WIRE SPARK CHAMBER WITH MAGNETOSTRICTIVE READOUT. Perez-Mendez, Victor (to United States Atomic Energy Commission). U. S. Patent 3,601,612. 24 Aug 1971. Filed 22 Aug 1969.

A wire spark chamber having magnetostrictive readout is described. One embodiment thereof is for particular use with low energy gamma rays, X-rays, or neutral particles whose presence is detected by secondary particles produced in converters placed in or around the wire planes of the chamber. Another embodiment has a very large and uniformly sensitive detecting area by means of auxiliary conducting planes which serve to charge the chamber capacity with a low impedance transmission-line characteristic. The embodiment for use with low energy gamma, X-ray or neutral particles has utilization in the field of medical diagnostics while the large chamber embodiment provides the capability of detecting multiple tracks with uniform high efficiency, thus fulfilling a long looked for need in the field of wire spark chambers. (auth)

4587 SIMPLE METHOD OF INCREASING MAGNETOSTRICTION SIGNALS IN SPARK CHAMBERS WITH MAGNETOSTRICTIVE READOUT. Boehmer, V.; Galster, S.; Schopper, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 96: No. 4, 601-3(1971).

A method which allows to increase by a factor of three the magnetostriction signal amplitudes in magnetically hard readout wires is described. The amplitude and half width of the signals are measured as a function of the signal path; results are compared with those obtained for magnetically hard and soft wires when the new method is not applied. (auth)

4588 PHOTOMETRIC METHOD IN ENERGY DETERMINATION OF COSMIC-RAY SHOWERS IN EMULSION CHAMBER. Ohta, Itaru (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 271-98(1971).

Since Japan–Brazil Emulsion Chamber Collaboration started in 1962 on Mt. Chacaltaya, x-ray films have been used together with nuclear emulsion plates for detection of the high energy cosmic-ray showers. Meanwhile, many members, Japanese and Brazilians, of this collaboration have made various attempts to use x-ray film for energy determination as well as for detection. The present work is developed in this basis. Application of the photometric method with x-ray films for energy determination of high energy electron showers gives us the following advantages. Firstly, signal to noise ratio of shower spot on x-ray film is much higher than that on nuclear emulsion plate, because of high sensitivity of x-ray films. Secondly, measurement of spot darkness of shower using micro-densitometer is more facile and more rapid, as compared with counting of electron tracks of the shower in nuclear emulsion plates. Consequently, the photometric method with x-ray film enabled us to make a scale-up of emulsion chamber with great stride. Photometric measurement and track counting method are applied simultaneously to each of 47 showers and the correspondence between spot darkness, D_{max}, and shower energy E_0, is established empirically. The relation is also calculated with three-dimensional shower theory. Both results agree well and give the relation $D_{max} \propto E_0^{0.85}$ for various energies. The method of energy determination for localized nuclear interaction in the chamber itself—Pb-jet shower—is also established empirically and theoretically. The same method as for electron shower is valid for Pb-jet showers with energy $\Sigma E_r \gtrsim 1$ TeV, if one uses slit larger than 150 μm radius in micro-densitometer. (auth)

4589 DETERMINING THE FALSE CURVATURE OF TRACKS IN A WILSON CHAMBER. Anishchenko, Yu. V. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 400-3(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 62-5(Mar-Apr 1971).

Convection currents which develop in a Wilson chamber due to the temperature difference between its inside and outside are considered, as is their effect on the shape of the tracks. Theoretical estimates are compared with experiments. (auth)

4590 NUMBER OF SENSITIVITY CENTERS IN THE MICROCRYSTALS OF A NUCLEAR PHOTOGRAPHIC EMULSION. Grishkina, T. V.; Kalashinova, V. I. (Moscow Engineering-Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 419-21(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 79-81(Mar-Apr 1971).

Based on the notion of statistical fluctuations of the number of sensitivity centers, it is shown that high sensitivity and equisensitivity of the microcrystals of a photographic emulsion are incompatible. The probability of the appearance of a microcrystal of a nuclear emulsion is calculated as a function of the magnitude of the elementary exposure. A relationship is established between the magnitude of the elementary exposure and the optimal number of sensitivity centers per microcrystal. (auth)

4591 MULTIWIRE PROPORTIONAL COUNTERS. Sutter, R. J. (Brookhaven National Lab., Upton, N. Y.). pp 264-83 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The subject of the multiwire proportional counter (MWPC) or "Charpak counter" is reviewed. Development of this type of detector has been spurred by advances in technology. The physical processes involved in the operation of MWPC's are discussed in some detail. Some of the results that have been obtained with multiple-wire counters are described; these include the important subject of spatial resolution. An important improvement in the MWPC is the discovery that addition of 0.2% freon 13B1 to an argon + isobutane mixture dramatically reduces the space charge effects limiting amplification and permits gains of 10^6. The paper concludes with a consideration of readout schemes from MWPC's. (R.W.R.)

4592 CHARACTERISTICS OF MAGNETOSTRICTION SPARK CHAMBERS FOR EXPERIMENTS UNDER CONDITIONS OF LARGE BACKGROUND LEVELS. Grigalashvili, T. S.; Zanevskii, Yu. V.; Peshekhonov, V. D.; Silaev, E. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 414-18(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 75-9(Mar-Apr 1971).

Those characteristics of magnetostriction spark chambers are given which are important when they are used in experiments with large background loads. A method is proposed for conducting investigations under laboratory conditions. It is shown that for an intensity of charged-particle background ~(3 to 5)10^6 sec^{-1}, the efficiency of a wire chamber with magnetostriction readout for the working track is at worst 95%. (auth)

4593 USE OF PULSED X RADIATION TO MEASURE THE CHARACTERISTICS OF NARROW-GAP SPARK CHAMBERS. Kanavets, V. P.; Martynov, V. I.; Ryl'tsov, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 411-13(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 72-5(Mar-Apr 1971).

Results are described of using pulsed x radiation to investigate the characteristics of narrow-gap spark chambers and to monitor their operation. The basic advantage of the method consists in the possibility of simulating a wide range of working modes of the chambers. It is shown that the use of pulsed x radiation allows the characteristics which are specific for relativistically charged particles to be reproduced with satisfactory accuracy. (auth)

4594 MEMORY TIME AND DEAD TIME OF A STREAMER CHAMBER. Anisimova, N. Z.; Davidenko, V. A.; Dolgoshein, B. A. (Moscow Engineering-Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 408-10(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 70-2(Mar-Apr 1971).

The effect of certain electronegative impurities on the memory time and dead time of a streamer chamber was investigated. For a variation of the memory time, an experimental investigation was made of the number of streamers per unit length of the track as a function of the time delay of the application of the high-voltage pulse. The cross section for the attachment of electrons to FS_6 molecules in the thermal range was measured. A transducer is described for monitoring the quantity of SF_6 in the working gas of the chamber; its characteristics are given. It is shown that the sensitivity of such a pickup is ~$1.5 \cdot 10^{-4}$ torr SF_6. (auth)

4595 MEMORY TIME OF WIRE SPARK CHAMBERS. Kanavets, V. P.; Martynov, V. I.; Ryl'sov, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 406-7(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 68-9(Mar-Apr 1971).

It is shown that a spark chamber with wire electrodes may have a noticeable efficiency for large time delays due to the diffusion of ions through the electrodes. Methods are presented for correcting the characteristics of such chambers. (auth)

4596 LOW-VOLTAGE SPARK CHAMBER. Avakyan, K. M.; Aivazyan, R. V.; Krishchyan, V. M.; Matevosyan, E. M. (Inst. of Physics, Erevan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 404-5(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 66-7(Mar-Apr 1971).

A spatial accuracy of $\sigma_z = 0.8 \cdot 10^{-2}$ m^{-1}, $\sigma_\varphi = 0.3 \cdot 10^{-3}$ rad was obtained in a spark chamber having a gap of 2×15 cm for a total electric field intensity of 1.5 kV/cm. It was shown that these results are not inferior to the data obtained when the chamber is supplied with a "normal" field intensity of 5 to 10 kV/cm. The quality and brightness of the tracks for such a low field intensity are fairly high and allow photography for an objective aperture of 1/11. The efficiency of recording a single particle is close to 100%. (auth)

4597 DIFFERENTIAL CHERENKOV COUNTER WITH A RATE RESOLVING POWER UP TO 2.10^{-6}. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 427-9(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 87-9(Mar-Apr 1971).

A gas differential Cherenkov counter is described. The length of the counter is 10 m. The angle of Cherenkov radiation is 11.7 mrad. The characteristics of the counter were investigated using particle beams from the 70 GeV accelerator of the Institute of High Energy Physics having momenta of 35 and 45 GeV/c. When the counter was filled with helium, a rate resolving power of $2 \cdot 10^{-6}$ was obtained. The background level was $3 \cdot 10^{-6}$. The counter may be used to separate pions and kaons having momenta up to ~200 GeV/c and kaons and protons (antiprotons) having momenta up to ~350 GeV/c. (auth)

4598 SCINTILLATION HODOSCOPE WITH LIGHT CODING. Bugorskii, A. P.; Borisov, A. A.; Derevshchikov, A. A.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 430-2(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 89-91(Mar-Apr 1971).

A scintillation hodoscope is described in which light coding is used in order to multiplex the information. Several versions of the hodoscope have been fabricated: (a) with scintillation elements having the dimensions $3 \times 5 \times 100$; $3 \times 3 \times 100$; $3 \times 2 \times 100$ mm, and a number of elements 16×16; (b) with scintillation elements having the dimensions $3 \times 5 \times 310$ mm and a number of elements 36×36. The characteristics of the hodoscopes were investigated using the beam of the accelerator at the Institute of High Energy Physics. (auth)

4599 TIME LOCKING OF A TOTAL-ABSORPTION SPECTROMETER BASED ON AN FEU-49 PHOTOMULTIPLIER. Aleksandrov, Yu. A.; Kozlov, V. A.; Kutsenko, A. V.; Maikov, V. N.; Pavlovskaya, V. V. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 387-9(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 52-4(Mar-Apr 1971).

The time locking circuit for a FÉU-49 photomultiplier operating in a Cherenkov total-absorption spectrometer designed according to the null discriminator principle with the addition of a pedestal is described. The range of recordable particle energies is 25 to 500 MeV, and the time shift does not exceed 2 nsec. The physical resolving time is ±15 nsec. (auth)

Radiation Dosimeters

Refer also to abstracts 4315 and 4348.

4600 IMPROVEMENT OF THE CALORIMETRIC SET FOR SMALL X AND GAMMA BEAM MEASUREMENTS. Kovarik, J.; Kovar, Z. (Inst. of Nuclear Research, Prague). Radioisotopy; 11: No. 6, 1037-52(1970). (In Czech).

The calorimetric set used in radiological dosimetry at the Nuclear Research Institute of Czechoslovak Academy of Sciences for roentgen radiation characteristic measurements has been modified for ^{60}Co gamma beam power measurements. The new arrangement of the calorimetric set, its electrical calibration in the semiadiabatic regime for gamma beam powers in the range 10 to 30 $\mu W \cdot cm^{-2}$, and results of absorbed beam power measurements of a ^{60}Co standard gamma beam source are described. The modified calorimeter allows the measuring of small X and gamma beam powers with mean quadratic deviations less than 2.5 per cent. (auth)

4601 CALORIMETRIC MEASUREMENTS OF THE CZECHOSLOVAK 16 MeV BETATRON X-RAY BEAM. Kovar, Z. (Inst. of Nuclear Research, Prague). Radioisotopy; 11: No. 6, 1019-36(1970). (In Czech).

The calorimeter used in radiological dosimetry at the Nuclear Research Institute of Czechoslovak Academy of Sciences has been modified for betatron X-ray beams measurements. The results of electrical calibration of this calorimeter in the range 0.5 to 5 mW for semiadiabatic and isothermic regime and the results of X-ray beam characteristics measurements for the 16 MeV betatron, developed in the Laboratory of Accelerators of the Institute of Plasma Physics of Czechoslovak Academy of Sciences, are described. The accuracy of the calorimetric determination of the absorbed X-ray beam power was better than ±1%. The results obtained for the intensity of this beam were compared with the value measured by means of an absolute thick-walled aluminum ionization chamber. The possibilities of further betatron beam characteristics measurements are discussed, especially the estimation of the correlation factor, energy fluence exposure and the definition of the effective energy for the X-ray spectra of Czechoslovak medical and industrial betatrons. (auth)

4602 DOSE RATE MEASUREMENTS BY SEVERAL RADOCON PROBES. Kanazawa, Tamotsu; Furuta, Junichiro. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 121-3(1970).

Several Radocon probes used in the irradiation facilities near Osaka were examined. Their observed values were compared relatively. There were large differences among them. It is necessary to compare the probes using absolute standard instrument. (auth)

4603 DOZIMETRIYA INTENSIVNYKH POTOKOV IONIZIRUYUSHCHIKH IZLUCHENII. (Dosimetry of Intense Fluxes of Ionizing Radiation). Generalova, V. V. (ed.). Svetloi Pamyati Dorogogo Uchitelya i Druga Sergeya Vasil'evicha Starodubtseva. Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1969). 184p.

Theoretical and experimental dosimetric studies on intense ionizing radiation fluxes are described. High-level fields of gamma, and mixed neutron-gamma radiation are considered, and techniques are given for spectrometry of differential and integral neutron fluxes. Topics include dosimetric equipment for recording electron beams from accelerators, intense fluxes of γ-radiation from isotopic sources, and reactor-generated neutrons. (tr-auth)

Radiometric Instruments

Refer also to abstract 4501.

4604 (ITJ-10) PARAMETERS OF THE ELECTRON-CAPTURE-TYPE BETA-IONIZATION DETECTORS DEVELOPED IN THE INSTITUTE OF NUCLEAR TECHNIQUES IN CRACOW. Lasa, J. (Institute of Nuclear Techniques, Krakow (Poland)). 1971. 26p. (In Polish). Dep. NTIS (U. S. Sales Only).

The principles of operation and construction of the electron-capture-type beta-ionization detectors developed in the Institute of Nuclear Techniques are presented. The circuits of the measuring systems, as well as the recommendations concerning the carrier gas choice for these detectors are given. The working parameters of the detectors described are compared with those of those commercially available. (auth)

4605 DIGITAL SETUP APPARATUS FOR RADIATION GAUGING AND CONTROLLING SYSTEMS. Shoemaker, David J.; Dewey, Rex W.; Griffith, James L.; Troutman, Paul H.; Wolf, Franklin A. (to Industrial Nucleonics Corp.). U. S. Patent 3,611,408. 5 Oct 1971. Filed 7 Apr 1969.

A radiation gauge equipped with a strip chart recorder for measuring the properties of moving materials is described. The recorder has a multiplicity of scales with selectively illuminated scale numerals, a measuring pen and pointer, and a specification target marking pen and pointer. The gauge includes a digital setup arrangement which receives decimal input numbers, indicative of the specification target value for the material to be measured and its composition, either from decimally numbered dials on the operator's control panel or from some other input device. Digital logic circuits responsive to the input numbers automatically select

the proper scale to be used and illuminate the proper scale numbers. The logic circuits use both the specification target numbers and the composition numbers to automatically and digitally select the center scale and span settings which properly calibrate the gauge for the material to be measured. The logic circuits further use these input numbers to control a digital to analog converter servomechanism which drives the specification target pen and pointer. The operation of this converter is automatically sequenced to mark successively on the moving recorder chart lines whose positions identify the scale used, the material composition measured and the specification target value. The final position of the target pen and pointer determines the set point for an automatic controller for the process machine which produces the measured material. (auth)

4606 APPLICATION OF GAMMA RADIATION BACK SCATTER TECHNIQUES TO THE MEASUREMENT OF SEDIMENT DENSITY. Swift, Jerry Johnson. Washington, D. C.; Catholic Univ. of America (1971). 154p. University Microfilms Order No. 71-23,099.

Thesis.

In the application of gamma radiation backscatter techniques to the measurement of sediment density, the energy spectrum of the detected backscattered gamma radiation was analyzed to determine the features of the spectrum providing the best measurement of the sediment density with minimal dependence on the chemical composition of the sediment. Experimental equipment used to generate backscattered spectra was a Co-60 source, four shields to limit single scattering and the exposure of the 3" × 3" NaI(Tl) detector, and aqueous solutions of zinc chloride, potassium carbonate, and sucrose for scattering media to simulate the sediment. The spectra, peakless continua, in the form of digital data were unfolded using the method of least squares, and examined by regression analysis for features providing a good measurement of density. The count of gamma radiation in the energy range from 250 to 300 keV was found to be the best measure of density. The accuracy of a measurement of density with the equipment used was within ± two percent at the ninety-five percent confidence level. (Diss. Abstr. Int., B)

4607 DENSITY OF THIN-WALLED ANTIFILTRATION IRRIGATION CANAL LININGS BY REFLECTED GAMMA RADIATION. Sinyakov, V. K.; Pavlov, L. S. Beton Zhelezobeton; 16: No. 12, 18-19(1970). (In Russian).

Non-destructive concrete inspection is possible with radioisotopic techniques. A method of reflected gamma radiation yields information concerning the density of surface layers 5 to 10 cm thick. The sensitivity of surface gamma-densimeters as a function of the depth is discussed. A comparison is made between the results of measurements with a surface gamma densimeter using a compensated detector and the density determined by gamma-translucence. It is concluded that the control of concrete density in thin-walled iron-concrete products offers promise. (K.S.W.)

4608 UTILIZATION OF ^{147}Pm AS AN IONIZATION SOURCE IN ELECTRON-CAPTURE DETECTORS. Lubkowitz, J. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas); Parker, W. C. J. Chromatogr.; 62: No. 1, 53-61(28 Oct 1971).

An electron-capture detector which utilizes promethium-147 as the ionization source has been studied for its use in pesticide analysis. A method has been found to electroplate promethium-147 on gold foils which can be heated to 400° without appreciable loss of activity. The properties of the foil as an ionization source are comparable to those of nickel-63. The detector has been used to analyze pesticides in aqueous media in the range 0.1–100 p.p.b. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 4180, 4451, 4500, 5034, 5469, 5902, 5916, 6280, 6281, and 6395.

4609 (BNWL-1611) DEVELOPMENT OF AN OPTICAL INSTRUMENT AND TECHNIQUE TO INDICATE TAMPERING WITH REACTOR FUEL ASSEMBLIES. Deichman, J. L.; Jolly, W. D.; Coleman, W. J. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971. Contract AT(45-1)-1830. 12p. Dep. NTIS.

The International Atomic Energy Agency (IAEA) and the United States Atomic Energy Commission (USAEC) have jointly sponsored research to develop a prototypic optical instrument to indicate tampering with reactor fuel assemblies. The instrument is intended to detect surface tampering in the form of minute markings or scratches which indicate that the fissionable material which was originally packaged might have been removed or diverted without authorization. The conceptual design for the optical instrument is described. The conceptual design includes features for split-image comparison, two-color comparison, chopped-image comparison and eye-to-eye comparison. The instrument is designed to be portable and compact, to require minimal operator training, and also to provide the capability for making permanent records. (auth)

4610 (CEA-N-1465) ON LINE ACQUISITION OF DATA IN PHOTONUCLEAR REACTIONS. Daujat, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 50p. (In French). Dep. NTIS (U. S. Sales Only).

The on-line data acquisition system used for photonuclear reactions of the (γ, xn) type obtained with a monochromatic γ beam at the 70 MeV linac at Saclay, consists of two interconnected devices. The STDAN which collects and stocks the experimental data and an on-line PDP8 I computer which evaluates these data, supervises the experiment controlling program and corrects some of linac parameters. (France)

4611 (INS-459) PROGRESS REPORT 16, JULY-DECEMBER 1970. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 96p. (SIR(INS)-5). Dep. NTIS (U. S. Sales Only).

Brief summaries are presented for research in the fields of nuclear physics, including instrumentation, accelerators, and data analysis equipment; radiation chemistry; stable isotope geochemistry, radioisotope dating and fallout; isotope applications; and instrumentation and electronics. Lists of current research projects, staff, and papers and reports issued during the period are appended. (C.E.S.)

4612 (IPP-7/5) STIGMATIC FOCUSSING PARTIAL PRESSURE ANALYZER WITH A TWO-CHAMBER ION SOURCE. Raskopf, K. F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1971. 43p. (In German). Dep. NTIS (U. S. Sales Only).

A partial pressure analyzer has been built, the ion source of which works with considerably reduced interaction. The analyzer shows both high absolute sensitivity and high partial pressure resolution. The disturbing interaction between the hot cathode (electron source) and the composition of the residual gas was eliminated by removing the cathode from the ionization volume. The electron beam is produced in a second chamber and enters the ionization chamber through a diaphragm with low conductance. The reaction products, which are created at the cathode by chemical reactions and thermal dissociation, are detected with very low probability ("two chamber technique"). Because of special ion optics (parallel entrance beam, 90° deflection by a "wedge-shaped" magnetic field) the combination of a static analyzer system and an ion source with large volume was achieved. The high sensitivity (10^{-4} A/torr or 1,2 $torr^{-1}$) and the good resolution (half-width-resolution: 65) is due to this fact. The over-all transmission was 12%. It is possible to operate the two chamber partial pressure analyzer in a conventional manner. The sensitivity is thereby increased to 10^{-2} A/torr. This is about an order of magnitude higher than the sensitivities of commercial instruments. A partial pressure of 3.10^{-13} torr is detectable without using a multiplier. (auth)

4613 VERSATILE PULSE GENERATOR SYSTEM FOR PULSED NMR APPLICATIONS. Ramadan, B.; Tward, E. (Univ. of Saskatchewan, Regina). Rev. Sci. Instrum.; 42: No. 11, 1618-22(Nov 1971).

A modular analog pulse generation system for use in pulsed NMR applications is described. All commonly used pulse sequences can be produced. The system offers the complete control of pulse width in the range of 0.5 to 500 μsec, pulse delays in the range 0 μsec to 1000-sec, and repetition rates in the range 10^{-3} Hz to 100 kHz. Pulse delays can be swept between any two delay times over the complete delay range and with a sweeping time in the range 10 μsec to 1000 sec. The output pulses from the system can be synchronized and thus made coherent with the rf sinusoidal wave form of the rf transmitter. (auth)

4614 SINGLE-COIL PROBE DAMPER FOR PULSED NUCLEAR MAGNETIC RESONANCE. Roeder, Stephen B. W.; Rhodes, Norman L.; Schmidt, Gregory W. (San Diego State Coll., Calif.). Rev. Sci. Instrum.; 42: No. 11, 1692-3(Nov 1971).

A circuit design is presented for a probe damper suitable for single coil NMR probes which improves the time for ringdown following an rf pulse by a factor of 2.5. The damping is provided for a precisely controlled time and removed positively to enable

the use of high-Q single-coil NMR probes for samples with very short T_2's. The damper can be adapted for use with negative or positive transmitter gating pulses. (auth)

4615 NANOSECOND RISETIME MEGAMPERE CURRENT MONITOR. Pellinen, D. G.; Spence, P. W. (Physics International Co., San Leandro, Calif.). Rev. Sci. Instrum.; 42: No. 11, 1699-1701(Nov 1971).

An integrating Rogowski coil has been used for measuring megampere current pulses in large electric fields in pulsed electron accelerators. The coil has a risetime of about 2 nsec and a typical sensitivity of 300 V/MA. (auth)

4616 COOLING METHOD FOR THE MOVING SOURCE IN MOESSBAUER SPECTROSCOPY EXPERIMENTS. Ortalli, Ida (Univ., Parma, Italy). Rev. Sci. Instrum.; 42, No. 11, 1739-40 (Nov 1971).

A cooling method for variable temperatures, for experiments on the Moessbauer effect is described. In the cryostat cooling the absorber (stationary), the gas is obtained by evaporating a liquid (N_2, He, H_2), while in the part that cools the source (in motion), the gas is nitrogen cooled with liquid nitrogen and the cooling is obtained by means of a direct flow of nitrogen cooled to the required temperature. (W.H.K.)

4617 MULTICHANNEL ANALYZER WITH ULTRASOUND-DELAY-CONDUIT. Moll, G.; Sanner, L. (Total Foerstner and Co., Ladenburg, Ger.). Atomwirt., Atomtech.; 16: No. 10, 535-7(Oct 1971). (In German).

A multichannel analyzer is described which processes a storage assembly with 8 delay-conduits producing signal delays of 64 μsec each. Two of such conduits are hooked up in series to a ring through which a conduction time of 128 μsec, representing the 128 channels, is obtained. In an analog digital transformer, a tooth-shaped voltage is produced with linear rise time of 128 μsec. The voltage is fed into a comparator that also receives the signal to be analyzed. Analog-digital and digital-analog transformations are described as well as the output of the storage content. (tr-auth)

4618 PROCEDURE FOR PRODUCING AN ION BEAM WITH A LARGE CROSS SECTION. Guernet, Georges (to Commissariat a l'Energie Atomique). French Patent 2,045,238. 15 Feb 1971. Filed 26 Jun 1969. (In French).

A procedure for producing an almost parallel ion beam of large cross section is presented. A parallel incident ion beam undergoes a double deflection in the X plane, and a second double deflection in the perpendicular Y plane; alternating fields of at least two different frequencies are used, these fields are parallel to the X and Y planes, and perpendicular to the direction of the incident beam. The beam may undergo successive deflections (X and Y) in two zones, or simultaneous deflections (X and Y) in the same zone Electrostatic or electromagnetic fields may be used. (auth)

4619 PHASE CONTROL CIRCUIT FOR HIGH SPEED ROTORS. Harling, O. K.; Svoboda, H. J. (Battelle-Northwest, Richland, Wash.). Nucl. Instrum. Methods; 96: No. 4, 609-11 (1971).

A simple phase control circuit is described which maintains the relative phase of high speed rotors at preset values. (auth)

4620 NUCLEAR DIGITAL FUNCTION GENERATORS AND MULTIPLIERS. Rao, D. N.; Taylor, D. (Univ. of Strathclyde, Scotland). Nucl. Instrum. Methods; 96: No. 4, 589-99(1971).

An α-radioactive source detector system with variable geometry the geometry being controlled by the parameter to be measured, can be employed as a digital transducer. It may also be used as a processing device, e.g. a circuit component, having an input/output characteristic, following, for example, any desired power law, say d^n, where the index n may be positive, negative, integer or fractional. Furthermore, if the detector is pulsed "on" and "off" at a frequency N, a multiplication stage may be provided, allowing laws of the type Nd^n to be followed, but scaling circuits may be necessary to ensure that the pulsing rate is compatible with the characteristics of the detector and the variable geometry (usually a variable aperture) unit. Details of typical designs and the performance possible are given, and it is shown that these devices are compatible with conventional electronic circuits, and may be employed conveniently in association with electronic components and in other cases as individual units. In both cases they appear to be capable of meeting important requirements. (auth)

4621 EFFECTS OF THE VARIATIONS OF THE INITIAL VELOCITY OF THE PHOTOELECTRONS ON THE IMPACT RESPONSE OF A PHOTOMULTIPLIER (SINGLE PHOTOELECTRON OPERATION). Miehe, J. A.; Knispel, G. (Centre National de la Recherche Scientifique, Strasbourg). Compt. Rend., Ser. B; 273: No. 7, 285-8(18 Aug 1971). (In French).

Short duration light pulses (350 ps) enabled the various components (fluctuations in the initial velocity of the photoelectrons and the electron transit times etc...) contributing to the broadening of the impact response of the photomultiplier, to be studied. (France)

4622 ION-IMPLANTED HIGH-FREQUENCY MOS TRANSISTORS. Shannon, J. M. (Mullard Research Labs., Redhill, Eng.). Philips Tech. Rev.; 31: No. 7-9, 267-70(1970).

MOS transistors have been made with a low feedback capacitance using ion implantation to implant the source and drain regions with the metal gate in position acting as a mask. All the available power gain from these autoregistered P-channel and N-channel devices made using boron and phosphorus ions respectively could be used without needing neutralization. The high-frequency performance of a MOS transistor has been improved further by making the drain junction area in high-resistivity material, thus reducing the parasitic drain capacitance. The channel region of the device is located in an implanted layer. Devices with implanted layers have been made with a maximum frequency of oscillation of 1.4 GHz. (auth)

4623 ION OPTICS. Boerboom, A. J. H. (FOM-Instituut voor Atoom- en Molekuulfysika, Amsterdam). pp 83-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The ion optics of mass spectrometers is discussed, and the concepts of emittance and pupils are explained. (W.H.K.)

4624 PARABOLA SPECTROGRAPHS WITH 2 AND 3 FIELDS AND THE PLANNED FISSION-PARTICLE PARABOLA SPECTROGRAPH AT GRENOBLE. Ewald, H. (Justus-Liebig Univ., Giessen, Ger.). pp 88-97 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A parabola spectrograph of about 20 meters that is under construction at the high-flux reactor at Grenoble where a neutron flux of 5×10^{14} n/s cm^2 will be available is described for analyzing high-energy fission product ions. (W.H.K.)

4625 HIGH-RESOLVING PARTICLE SPECTROMETERS OF LARGE TRANSMISSION. Wollnik, H. (Justus Liebig Univ., Giessen, Ger.). pp 169-74 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The problem of image aberrations in high-transmission, high-resolution mass spectrometers is studied. (W.H.K.)

4626 INCREASE OF RESOLVING POWER BY THE MULTI-PASSAGE MASS SPECTROMETER. Baril, M.; Fortin, M. (Univ., Laval, Quebec). pp 194-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The theoretical design and preliminary results on a multipassage magnetic mass spectrometer are briefly described. (W.H.K.)

4627 INFLUENCE OF ION INITIAL ENERGIES ON THE DISCRIMINATION IN A NIER ION SOURCE OPERATING WITHOUT AN AUXILIARY MAGNETIC FIELD AND NEGLECTING THE SPACE-CHARGE EFFECT. Chantreau, J.; Vauthier, R. (Faculte des Sciences, Poitiers, France). pp 198-204 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A quantitative evaluation of the influence of ion initial energies on the ionic yield of a Nier ion source operated at various ion accelerating voltages is attempted. A theoretical study of this yield is presented under some simplifying assumptions the most important of which are the ion source is operated without auxiliary magnetic fields and space-charge effects in the ion chamber are neglected. Experimental results are given at operating conditions which meet the theoretical hypotheses. The discrepancies between experimental results and the calculated one are interpreted as due to space-charge phenomena in the ion chamber. (auth)

4628 APPLICATION OF THE ION MICROPROBE MASS ANALYZER. Andersen, C. A.; Roden, H. J.; Robinson, C. F.

(Hasler Research Center, Goleta, Calif.). pp 215-24 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The design and performance of an ion microprobe mass analyzer are discussed. The solid target sample is sputtered by an ion beam, and the sputtered sample ion beam is mass analyzed. (W.H.K.)

4629 WIDE-ANGLE MASS SPECTROMETER. Blauth, E. W.; Weissmann, R. (Institut fuer Plasmaphysik GmbH, Munich). pp 225-30 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The spectrometer has a horizontal angle of divergence of 60° and accepts a solid angle of 0.1 sterad. The resolving power can be increased from A = 40 to 255 by limiting the horizontal angle of divergence. The emission yield of the electron impact ion source is 0.5. A transmission coefficient of 0.25 is achieved with this combination ion source and separating system. (auth)

4630 SMALL HIGH-SENSITIVE MASS SPECTROMETER. Takeshita, I.; Nakao, F. (Matsushita Electric Industrial Co., Ltd., Osaka). pp 231-5 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Design modifications on a small mass spectrometer for residual gas analysis in vacuum are briefly described. A corrected beam focusing system and an improved ion source are described. (W.H.K.)

4631 NEW 30 cm RADIUS MASS SPECTROMETER FOR HIGH SPEED ACCURATE ISOTOPIC ABUNDANCE MEASUREMENT. Kurasawa, H. (Geological Survey of Japan, Kawasaki); Ando, N.; Shirahase, T.; Naito, M. pp 236-44 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A Nier-type single focusing mass spectrometer with a mean magnetic field radius of 30 cm is described. Performance data are briefly discussed. (W.H.K.)

4632 TIME-OF-FLIGHT MASS SPECTROMETER WITH A 90^0 ELECTROSTATIC ENERGY ANALYZER. Su, Ching-shen (National Tsing Hua Univ., Hsinchu, Taiwan). pp 245-8 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A new type time-of-flight mass spectrometer has been constructed which utilizes a 90° electrostatic lens of 50 cm mean radius of curvature as an energy analyzer. The distinguishing feature of this instrument is that the mass resolution of this spectrometer is chiefly determined by the energy resolution of the electrostatic energy analyzer which is inversely proportional to the mean radius. The theoretical resolution of this spectrometer is $1/250$ at 2mm slit width of the energy analyzer. (auth)

4633 DEVELOPMENT OF A MASS SPECTROMETER EQUIPPED WITH BOTH A CONVERTIBLE KNUDSEN CELL ION SOURCE AND A R. F. SPARK ION SOURCE. Watanabe, E.; Naito, M. (Japan Electron Optics Lab., Akishima). pp 249-56 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A universal-type Mattauch–Herzog type double-focusing mass spectrometer capable of using both an rf spark ion source and a Knudsen cell ion source is briefly described. (W.H.K.)

4634 SIMULATION OF ION TRAJECTORY IN A QUADRUPOLE MASS FILTER. Kondo, T.; Taya, S.; Omura, I. (Central Research Lab., Hitachi Ltd., Tokyo). pp 269-72 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The transient solution of the Mathieu equation is obtained by analog computation, and some characteristics of the quadrupole mass filter are explained from the computation. Also, a new method of measuring the radial velocity distribution of the incoming ion current in the mass filter is shown and discussed. (W.H.K.)

4635 EXPERIENCES WITH A LOW-VOLTAGE DISCHARGE ION SOURCE APPLIED TO A COMMERCIAL MASS SPECTROMETER. Franzen, J. (Institut fuer Spektrochemie, Dortmund, Ger.). pp 296-9 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The operation and performance of a low-voltage discharge ion source with a GEC/AEI MS7 mass spectrometer are briefly discussed. (W.H.K.)

4636 EFFECTS OF SOURCE PARAMETERS ON THE ION INTENSITY IN A TRIGGERED DC SPARK SOURCE MASS SPECTROGRAPH. Kammori, O.; Yamaguchi, N.; Sato, K.; Suzuki, R. (Yawata Iron and Steel Co., Ltd., Kawasaki, Japan). pp 300-5 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The experiment was carried out with a CEC 21-110B type double-focusing mass spectrograph equipped with a triggered dc spark source. The source parameters studied were sustain voltage (0–800 V), triggered voltage (0–3000 V), pulse length (0–10 μsec), sustain capacitance (0.5–20 μF), and frequency (10–3000 Hz). (W.H.K.)

4637 RECENT ENHANCEMENT OF DETECTABILITY IN R. F. SPARK SOURCE MASS SPECTROMETER. Enomoto, S.; Aoyama, T. (Japan Electron Optics Lab. Co., Ltd., Akishima, Japan). pp 334-8 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The problems of long detection time requirements and background fogging with the spark source mass spectrometer have been solved. The accelerating voltage was increased to 30 kV, the pulse repetition frequency was increased, and the vacuum system was modified. (W.H.K.)

4638 ANALYTICAL IMPROVEMENTS IN SPARK SOURCE MASS SPECTROMETRY. Valeriano, P.; Vastel, J. (Thomson-C. S. F., Chatou, France). pp 351-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The characteristics of spark source mass spectrometers are briefly discussed, particularly its high resolving powers. (W.H.K.)

4639 HIGH SPEED AUTOMATIC DATA ANALYSIS FOR SPARK ION SOURCE MASS SPECTROMETRY. Saito, M.; Higashino, H. (Japan Electron Optics Lab. Co., Ltd., Akishima). pp 358-61 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The method for automatic data analysis for spark source mass spectrometry using a computer and automatic comparator–densitometer system is described. The flow chart is given. (W.H.K.)

4640 DRIFT TUBE MASS SPECTROMETRY. Kaneko, Y.; Kobayashi, N.; Kanomata, I. (Tokyo Univ.). pp 944-8 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The operating principle of drift tube mass spectrometry is discussed, and the apparatus is described. (W.H.K.)

4641 UNIVERSAL NEUTRON DIFFRACTOMETER HAVING A VARIABLE WAVELENGTH. Somenkov, V. A.; Amirkhanov, K. P.; Zemlyanov, M. G.; Marukhin, V. I.; Shil'shtein, S. Sh. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 397-9(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 60-2(Mar-Apr 1971).

A two-crystal neutron diffractometer for monochromatic neutrons, which has a variable wavelength and is mounted in the horizontal channel of an IRT-M pulsed reactor, is described. A

new solution was used in the instrument for the construction of the movable iron-water radiation shielding of the monochromator section under conditions of limited space. (auth)

4642 MASS SPECTROMETER FOR PRECISION ISOTOPIC ANALYSIS OF HYDROGEN. Abashidze, I. V.; Artemchuk, V. G.; Vetshtein, V. E.; Gol'denfel'd, I. E. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 540-2(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 182-4(Mar-Apr 1971).

The MI-1305 mass spectrometer has been re-equipped for precision measurements of the D/H ratio. The chamber of the mass analyzer has been widened sufficiently in the region of the ion receiver to install a two-collector ion-current detector. The D/H ratio is measured by a compensating comparison circuit using a four-valve feed system which alternates inlet of the sample and the standard. The formation of H_3^+ ions is suppressed by introducing an "ejecting" electric field into the ionization chamber of the source. The error in determining the relative content of D in natural compounds is +0.3%. (auth)

4643 X-RAY ANALYZER WITH A Ge(Li)-DETECTOR. Baldin, S. A.; Ioannesyants, L. M. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 424-6(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 84-6(Mar-Apr 1971).

The possibility of using a Ge(Li)-detector to analyze elements with Z > 50 according to their characteristic x-ray K-spectra was considered. An x-ray analyzer (resolving power $\Delta_{\frac{1}{2}} = 1.25$ keV for an energy ~100 keV) was used to measure the limiting analysis sensitivity for a series of elements in the range of Z = 50 to 92 for excitation of the characteristic radiation by ^{147}Pm, ^{170}Tm, ^{57}Co, and ^{109}Cd sources. (auth)

4644 SYSTEM FOR TRANSMITTING EXPERIMENTAL DATA. Dubrovskii, O. A.; Matalin, L. A.; Smirnov, V. I.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 441-5(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 98-102(Mar-Apr 1971).

A system is described which allows two-way exchange of information to be achieved between a small "Nairi" electronic computer which is included in a measurement-recording complex, and an M-20 electronic computer at a computing center. A standard telephone line which is commutated via the automatic telephone exchange of the enterprise is used as the communication line. The experimental data which are to be processed are entered in the on-line memory of the "Nairi" from a punched tape by means of a fast photoreadout device, or from the machine on-line memory of the measurement center through a matching rack which may exchange full-digit machine words with the "Nairi" computer. The system ensures transmission of experimental data directly to the machine on-line memory of the M-20, performance of the appropriate calculations, and delivery of the results of the calculation back to the measurement center. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 5152, 5608, 5618–5620, 5624, and 5625.

4645 (N-71-34225) RADIATION EFFECTS IN MOS INTEGRATED CIRCUITS. Final Report, October 20, 1969–October 20, 1970. Brashears, Sidney S.; Thomsen, M. P. R. (Electro-Mechanical Research, Inc., College Park, Md.). Oct 1970. Contract NAS5-21106. 17p. (NASA-CR-121623). NTIS.

Integrated circuits containing MOSFETs were subjected to 1-MeV electrons. Damage and annealing rates were measured as a function of irradiation dosage, dose rate, annealing temperature, and composition of MOSFET components. (auth) (STAR)

4646 CIRCUIT FOR GENERATING A PULSE IN RESPONSE TO A RADIATION BURST. Husa, Ronald G. (to United States Atomic Energy Commission). U. S. Patent 3,602,742. 31 Aug 1971. Filed 3 Jul 1969.

A solid state circuit which generates an electrical output pulse upon application of an electrical impulse from a radiation burst detector or of the radiation burst itself is described. The circuit utilizes a resistance-capacitance regeneration timing loop to activate a saturation holding circuit which causes a trigger circuit to continue conduction to sustain the output pulse from an output circuit for a predetermined time proportional to the resistance-capacitance time constant of the regeneration loop. (auth)

4647 TRANSIENT PHENOMENA OBSERVED WITH PULSED RADIATIONS FROM A LINEAR ELECTRON ACCELERATOR. Okabe, Shigeru; Tsumori, Kunihiko; Tabata, Tatsuo; Kawabata, Keisuke. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 61-6 (1970).

Transient phenomena of physical interest using pulsed radiations from a linear electron accelerator are studied including (1) drift of the pulsed-radiation-induced current in crystalline quartz with irradiation time and its dependence on angle between the crystal axis and the applied electric field, (2) after-pulse phenomenon in the ionization chamber filled with various kinds of gas, occurring with some dependence on radiation intensity and applied electric field, and (3) transient emission in ionization chambers, probably caused by charged gas molecules absorbed on the surfaces of chamber material. The third phenomenon is considered to have a serious effect on the use of ionization chambers. (auth)

4648 ANNUAL CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS, UNIVERSITY PARK, PENNSYLVANIA, JULY 8–11, 1969. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 1-303(Dec 1969). (CONF-690704).

Separate abstracts were prepared for 35 of the 40 papers presented. Four of the papers were previously included in NSA (23: 36789, 36790, 35573, 35574), and one paper was out of scope. (W.H.K.)

For abstracts of individual papers see: 4319, 4649–4669, 5152, 5584–5586, and 5613–5621.

4649 OPTIMIZATION OF THE NEUTRON RADIATION TOLERANCE OF JUNCTION FIELD EFFECT TRANSISTORS. George, William L. (Motorola Semiconductor Products Div., Phoenix, Ariz.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 81-6(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The fast neutron irradiation induced degradation of junction field effect transistors has been studied in detail. A comparison of p-channel to n-channel devices had confirmed reported differences in hole and electron removal rates. The predicted increase of hardness with increasing channel dopant concentration is experimentally demonstrated, although channel dopant grading makes very heavily doped units difficult to attain in practice. Also, a device modification which allows attainment of breakdown voltages higher than those characteristic of the channel doping level is presented and experimentally verified. This modification made possible the construction of devices with breakdown voltages greater than fifty volts, which degraded by only 25% in transconductance at fluences of approximately 1 to 3×10^{15} neutrons/cm^2 (E > 10 keV, Triga). Thus, the technique offers promise in the construction of very radiation resistant devices with wide operating voltage ranges. (auth)

4650 RADIATION EFFECTS ON JUNCTION FIELD EFFECT TRANSISTORS. Shedd, W.; Buchanan, B.; Dolan, R. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 87-95(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Experimentally determined permanent and transient effects of radiation on the electrical characteristics of junction field effect transistors (JFET's) are presented for JFET's exposed to energetic neutron doses up to 10^{16} neutrons/cm^2 (E > 10 keV) and ionizing radiation up to 8×10^9 rad/sec. Results of extensive transient radiation experiments using the AFCRL Linac are presented for various combinations of channel doping, gate resistor values, gate voltages, drain voltages, gold doping and dose rates. Limited new experimental data are presented on neutron damage. Existing neutron degradation data on hardened JFET's are summarized. The JFET neutron degradation theory is summarized and refined. (auth)

4651 RADIATION-INDUCED INTEGRATED CIRCUIT LATCHUP. Leavy, J. F.; Poll, R. A. (Systems, Science, and Software, La Jolla, Calif.). Contract N00014-68-C-0258. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 96-103(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Integrated circuit (IC) structures and associated physical mechanisms which are responsible for the phenomenon of radiation-induced latchup are discussed. Laboratory measurements on selected IC's have verified that the structures described will support latchup. These measurements are briefly discussed. An important result of the laboratory measurements has been to establish that electrical tests can be used to identify latchup-prone

structures within an IC. A careful analysis of a given IC's topology can uncover all latchup-prone structures. Once such structures have been identified, appropriate electrical testing can be implemented during the IC production phase to determine the V-I characteristics of these paths. This procedure will supply the necessary information regarding the biasing conditions required for the initiation of the latchup paths when the IC is exposed to an ionizing radiation environment. It is concluded that four-layer (p-n-p-n) action is the primary latchup sustaining mechanism, while transistor sustaining voltage breakdown is of little concern and second breakdown is probably of minor importance for most IC's. Second breakdown must be given careful consideration, however, before a given IC can be considered to be latchup free. The available evidence suggests that inter-element p-n-p-n paths in IC's constructed with epitaxial processes, and utilizing a highly-doped buried layer, are not sensitive to latchup initiation by photocurrents. (W.H.K.)

4652 TRANSIENT RADIATION RESPONSE OF COMPLEMENTARY-SYMMETRY MOS INTEGRATED CIRCUITS. Dennehy, W. J.; Holmes-Siedle, A. G.; Leopold, W. F. (RCA Astro-Electronics Div., Princeton, N. J.). Contract F33615-67C-1140. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 114-19(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Complementary-symmetry MOS (CMOS) integrated circuits were subjected to a sub-microsecond burst of high intensity ionizing radiation using 10-MeV electrons from a LINAC. The results show that, at peak dose-rate values of less than 8×10^8 rads (Si)/s, the transient change in output voltage of a CMOS inverter is small and can be attributed simply to the net junction photocurrent flowing at the output node. At dose rates in excess of 8×10^8 rads (Si)/s, however, a new type of response comes into play and the transient change in output voltage becomes very large, approaching the operating voltage. In some instances, this change can result in a nondestructive temporary latch-up condition. The results suggest that this condition is caused by a parasitic effect, namely the interaction of the P-well, the source-drain diffusions, and the protection diodes that constitute a four layer structure. (auth)

4653 RADIATION-INDUCED SECOND BREAKDOWN IN TRANSISTORS. Carr, E. A.; Binder, D. (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 120-3(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Second breakdown was induced in the 2N914 transistor by electron pulses from a 10 MeV Linac. The typical time delay for the initiation of breakdown was observed as well as the reduction in time delay with increasing voltage. In addition, a transistor subject to a nonlimited breakdown was observed to fail by a collector-to-emitter short. Threshold voltages for second breakdown were observed to decrease with increasing dose rate in the BV_{CER} and BV_{CEX} modes. At 1 or 2×10^{10} rad(Si)/sec the voltage decreased below the rated (BV_{CEO}) voltage of the 2N914 transistor. (auth)

4654 SHORT-TERM RADIATION-INDUCED CONDUCTIVITY IN POLYSTYRENE FILMS WITH NARROW MOLECULAR WEIGHT DISTRIBUTIONS. Boesch, H. E. Jr.; Hill, A. S. (Harry Diamond Labs., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 124-9(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Thin disk dielectric film capacitors were prepared from a series of special monodisperse polystyrenes and irradiated in a flash x-ray facility. Transient conductivity in the films was measured with time resolution ≈5 ns, for dose rates from 10^7 to 5×10^{10} rad/sec, and related to a kinetic model dominated by carrier trapping. Estimates for constants associated with a class of shallow traps were obtained for the assumed model. No significant molecular weight dependence of the early-time induced conductivity was found. Molecular weight-dependent departures from second order decay kinetics were noted. (auth)

4655 RADIATION EFFECTS IN SWEPT-SYNTHETIC QUARTZ. Flanagan, T. M.; Wrobel, T. F. (Gulf General Atomic Inc., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 130-7(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The results of a radiation testing program on swept-synthetic quartz resonators and materials are presented. Thirteen resonators representing eight bars of Z-growth, swept-synthetic quartz were tested for transient frequency drifts and accumulated frequency offset. When the drift due to the temperature change induced by a radiation pulse equilibrates, a relatively permanent frequency offset which changes with dose is observed. Typical frequency changes are found to be approximately +2 pp 10^8 for doses of a few kilorads to about 5×10^4 rads and −1 pp 10^7 after 2×10^5 rads. Crystals cut from the same bar exhibit frequency shifts which differ by about 1 pp 10^8 for a given dose, but crystals from different bars differ by larger amounts for a given dose. Changes observed in a resonator irradiated in a mixed gamma-neutron environment to 175 kilorads and 3×10^{14} n/cm^2 cannot be accounted for by ionization-induced changes alone. Positive frequency shifts, linear in neutron fluence, are observed. Electron spin resonance and transient and steady-state optical absorption measurements were performed on pieces of the parent material in an attempt to correlate the observed frequency changes with defect properties. Two radiation-induced electron spin resonance centers were observed, one of which appears to anneal at the same temperature as the frequency shift due to ionizing radiation. Predictions of frequency shifts with accuracies of approximately 1 pp 10^7 can be made from measurements of a piece of a bar. More accurate predictions require the testing of a finished oscillator from each bar. (auth)

4656 TECHNIQUE FOR ESTIMATING PRIMARY PHOTOCURRENTS IN SILICON BIPOLAR TRANSISTORS. Notthoff, J. K. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 138-43(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

It is often difficult to radiation-test the transistors of interest in the initial phases of a program involving radiation-hardened circuit design. As a result, a convenient way is needed of estimating primary photocurrents in transistors due to gamma radiation which does not involve measuring or testing devices. A new method of predicting primary photocurrent is advanced which makes it possible to calculate I_{pp} from manufacturer's data sheets, making it unnecessary to have any measurements or test performed. (auth)

4657 TRANSIENT RADIATION CURRENT GENERATOR MODEL FOR SEMICONDUCTOR DEVICES. Dierking, W. H.; Katz, G. E.; Steele, E. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 144-52(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Mathematical models of devices can generally be classified into one of two categories. The first model is formulated on physical properties of the device through a series of complex equations dependent upon doping levels, fabricating processes, and geometry. The second model is formulated on the basis of an equivalent electrical circuit which simulates the observable electrical behavior. The improved mathematical model for describing the photogenerated current in a radiated p-n junction described, falls into the second category, and is intended for use in the Transient Radiation Analysis by Computer (TRAC) family of transient circuit analysis programs. (auth)

4658 RADIATION HARDENING OF ELECTRONIC SYSTEMS. Messenger, G. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 160-8(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The hardening of electronic systems against nuclear radiation environments is discussed. A combination of shielding, special circuit design techniques, and use of hardened components is required. The difficulty and cost involved in proof testing is reduced by using a substantial degree of overdesign, allowing the proof tests to be success oriented. Overstress techniques can be used to estimate system failure probability, which is very effective for neutron degradation failure modes and very useful although not completely reliable for surface dose and photocurrent catastrophic failure modes. (W.H.K.)

4659 FIELD COUPLING TRANSFER FUNCTIONS FOR THE TRANSMISSION LINE CABLE MODEL: AN EXPERIMENTAL VERIFICATION. Whitescarver, C. D. (Martin Marietta Corp., Orlando, Fla.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 169-71(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The result of an experimental investigation of the coupling of transient electromagnetic fields with two-wire uniform transmission line cable models is given. A long wire antenna was used as

the transient radiation source in the experimental verification of the theoretical electromagnetic field coupling transfer functions for the transmission line cable model. The basic theoretical coupling concepts were applied with the aid of computer programs to the specimen transmission line in the experimental environment to obtain the analytical responses. On the basis of the comparison of the analytical responses with the experimental results, it was concluded that the field coupling transfer functions for the transmission line model are valid. (auth)

4660 CHARACTERIZATION AND MODELING OF THE 709 INTEGRATED CIRCUIT OPERATIONAL AMPLIFIER IN AN IONIZING RADIATION ENVIRONMENT. Nichols, J. S.; Alexander, D. R.; Hittinger, G. N. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 172-6(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

An empirical technique for simplified computer modeling of a 709 operational amplifier integrated circuit in an ionizing radiation environment is presented. The model makes use of an RLC network and a voltage-transfer curve to model the normal electrical operation of the 709. An additional voltage generator models the radiation response. Comparisons between the radiation response predicted by the model and observed radiation response are shown. (auth)

4661 DESIGN AND PERFORMANCE OF AN INTEGRATED CIRCUIT FLIP FLOP WITH PHOTOCURRENT COMPENSATION. Aiken, J. G. (Texas Instruments Inc., Dallas); Crabbe, J. S.; Spence, H. W.; Kinoshita, G.; Phillips, H. Contract F30603-67-C-0261. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 177-80(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The design and testing of a dielectrically isolated integrated circuit Set-Reset (RS) flip flop is described. The flip flops were fabricated with bipolar transistors having a primary photocurrent sensitivity of 3 to 5×10^{-11} mA/rad(Si)/s. The flip flops were capable of being switched on clock command during a 400 nsec electron beam pulse with a peak dose rate of 1.6×10^{11} rad(Si)/s. (auth)

4662 COMPARISON OF THE IONIZING RADIATION RESPONSE OF MICROCIRCUITS MANUFACTURED BY FIVE DIFFERENT TECHNOLOGIES. Nichols, D. K.; Nielsen, R. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 181-5(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The ionizing radiation responses of seven integrated circuit types having different circuit functions are considered. Each circuit type was manufactured using several different construction technologies. In all, five technologies have been theoretically and experimentally analyzed. A comparison illustrates the degree of improvement and the differences in resulting failure modes when more advanced technologies are used. (auth)

4663 ANALYSIS OF RADIATION EFFECTS IN AND HARDENING OF INTEGRATED CIRCUIT VOLTAGE REGULATORS. Crowe, J. W. (Hughes Aircraft Co., Culver City, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 186-94(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The dominant sensitivity of the basic analog voltage regulator to small-signal transient radiation is identified by analysis and experiment. Various methods of circuit hardening are considered. Hardening by diode compensation is demonstrated. (auth)

4664 RADIATION-INDUCED PERTURBATIONS OF THE ELECTRICAL PROPERTIES OF THE SILICON–SILICON DIOXIDE INTERFACE. Hughes, H. L. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 195-202(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Interface-state densities and MOS transistor characteristics dependent upon such states have been studied as a function of radiation dose and type. Special MOS devices possessing doped silicon dioxide layers as well as undoped "control" devices have been utilized. Infrared absorption measurements were performed on silicon dioxide samples before and after exposure to radiation, as well as for doped and undoped samples. A model based on structural modifications of the silicon dioxide films is proposed for the buildup of interface states resulting from exposure to radiation. It has been found that with the proper doping of the silicon dioxide films, the buildup of such states can be reduced. Using such doped gate-dielectrics, planar semiconductor devices much less sensitive to radiation have been fabricated. (auth)

4665 EFFECTS OF METALLIC DOPING ON IONIZATION DAMAGE IN MOS FETS. Kjar, R. A.; Peel, J. L.; Wrigley, C. Y. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 207-10(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Detailed studies of radiation damage in metal-oxide-semiconductor (MOS) transistors show that the damage due to ionizing radiation is substantially different if chromium is added to the gate oxide. Devices with chromium consistently show smaller gate threshold shifts (due to positive charge storage in the gate oxide) when irradiated with zero or negative gate bias; they also show smaller increases in interface state density. The generation of interface states by radiation is also bias dependent in chromium MOS devices. Another difference between devices with conventional and chromium-doped oxides is the lower rate of thermal annealing when chromium is used. An extended anneal at 350°C is required to remove radiation damage from these devices. A considerable degree of control over ionization damage is thus obtained by chromium doping, and it appears this control can be used to improve radiation hardness of MOS transistors. (auth)

4666 RADIATION-INSENSITIVE SILICON OXYNITRIDE FILMS FOR USE IN SILICON DEVICES. Schmidt, P. F.; Rand, M. J.; Mitchell, J. P.; Ashner, J. D. (Bell Telephone Labs., Inc., Allentown, Pa. Bell Telephone Labs., Inc., Whippany, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 211-19(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Silicon oxynitride (SiON) films (in MIS structures) with compositions near Si_2ON_2 are nearly insensitive to space-charge built-up for radiation doses up to ~10 Mrads. Bias during irradiation does not lead to instability unless certain threshold field values are exceeded. These values are 2.8×10^5 V/cm for negative bias and 1.5×10^6 V/cm for positive. Above the threshold for negative bias there is negative charge injection by the metal contact. The shift of the C-V curve, ΔV_{fb}, is linearly related to the applied bias, V_A: $\Delta V_{fb} = V_{TH} - V_A$ (V_{TH} is the threshold voltage). The composition range of interest is characterized by refractive indices from 1.74 to 1.82. The films are good barriers to sodium drift at 160°C, but are permeable to hydrogen gas and allow the usual annealing of interface states. Films deposited on bare Si surfaces show large negative V_{fb}. To obtain low surface charge densities, a thin SiO_2 layer (40 to 180 Å) can be interposed between the SiON and Si or the Si surface can be pretreated chemically (~15 Å SiO_2). Neither treatment affects radiation hardness. In preliminary bias-temperature tests (4 hours, 300°C, $\pm 1.5 \times 10^6$ V/cm) SiON films showed nonionic-type drifts. For either bias polarity, films with interlayers showed drifts $\gtrsim 2$ V; those with pretreated Si surfaces showed drifts ~3 V for negative bias and no drifts for positive. SiON films on bare Si surfaces are less stable (drifts ~5 to 10 V) due to injection from the Si electrode. The mechanisms producing radiation hardness in these films appears to be a fast recombination of radiation-induced carriers with approximately balanced densities of deep hole and electron traps. The almost complete absence of cathodoluminescence in the oxynitride films supports this theory. In contrast, SiO_2 films show considerable cathodoluminescence peaked at 4500 Å with a 4-ms decay time. (auth)

4667 RADIATION EFFECTS ON SILICON SCHOTTKY BARRIERS. Yu, A. Y. C.; Snow, E. H. (Fairchild Semiconductor Research and Development Lab., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 220-6(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Because of a variety of important new applications, it is desirable to determine the effects of radiation on silicon Schottky barrier diodes. In the present study, both neutron and low-energy electron irradiation were employed and a variety of Schottky diode structures were investigated. These included the p-n junction guard ring structure and gate-controlled structure which was used to separate surface from bulk effects. The two main effects of low-energy electron irradiation are: increase of surface recombination velocity and buildup of a positive space charge in the oxide. These results are consistent with previous studies of p-n junction diodes. For Schottky diodes without gate electrodes, the breakdown voltage is decreased and some excess current is present at low forward bias after irradiation. The effects of nuclear irradiation are (in addition to the surface ef-

fects mentioned above): decrease of bulk lifetime and carrier removal, again consistent with previous studies on p-n junction devices. Recombination-generation current increases manyfold due to the decrease in lifetime after irradiation. This component of current is important for Pt Schottky diodes which have a high barrier (0.85 eV). However, for Al diodes, since the barrier is relatively low (0.69 eV) and the thermionic emission current relatively high, recombination-generation current is not important until very high neutron dosage. (auth)

4668 PERMANENT RADIATION EFFECTS IN COMPLEMENTARY-SYMMETRY MOS INTEGRATED CIRCUITS. Poch, W.; Holmes-Siedle, A. G. (RCA Astro-Electronics Div., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 227-32(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The predominant effect of radiation on a typical metal-oxide-semiconductor (MOS) transistor is a shift in the threshold or "cut-off" voltage of the device. Since these devices are in other respects extremely well suited to space applications, the problem of estimating and accommodating the anticipated threshold voltage shift has been examined. Guidelines which will assist the designer to predict the limits within which the values of these changes will fall are presented. These predictions are based on extensive tests of complementary-symmetry MOS devices, as well as the more conventional MOS transistors and integrated circuits. A parallel research program has provided a better understanding of the damage effects. The results of radiation-testing a wide variety of MOS devices that can be used for estimating the anticipated threshold voltage shift at various dose levels are presented. Also, data on the behavior of MOS devices when gate bias during irradiation is applied intermittently instead of continuously are presented. (auth)

4669 RADIATION EFFECTS IN COAXIAL CABLES. Kerris, K. G.; Berggren, C. C.; Carter, D. B.; Spehar, G. G. (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 264-70(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The results of a systematic study of the interaction of cable systems with ionizing radiation fields are presented, with a view toward achieving a fundamental understanding of the effects governing radiation induced cable signals. The study led to the construction of a physical model which was used to obtain a quantitative description of the dominant processes involved in the interaction. The model is sufficiently comprehensive to permit the calculation of the current induced in the conductors of a coaxial or triaxial cable system (or, indeed, almost any other system of conductors separated by an insulating medium) for any combination of incident photon and electron spectra. A number of experiments was performed to support the calculations. The validity of the model is demonstrated by showing that the experimental data verify the theoretical calculations. (auth)

4670 PHOTOMULTIPLIERS IN RADIATION FIELDS (REVIEW). Lyutsko, A. M.; Pertsov, A. N. (Belorussian State Univ., Minsk). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 335-44(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 7-15(Mar-Apr 1971).

The results obtained from a study of the effects of ionizing radiation of various types, intensity, and energy on the output current, amplitude distribution of the output pulses, integral sensitivity, and intrinsic resolution of various types of photomultipliers are analyzed. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstract 4241.

4671 SIMPLIFICATION OF THE RADIOACTIVE ANTIGEN-BINDING TEST BY A DOUBLE LABEL TECHNIQUE. Gotschlich, Emil C. (Rockefeller Univ., New York). J. Immunol.; 107: No. 3, 910-11(Sep 1971).

A radioactive antigen-binding test is described that requires neither the removal of an accurate sample of the supernatant nor the washing of the precipitate. The basis of this method is to add radioactive ^{22}Na to the ^{125}I-labeled antigen as a volume marker. After sedimentation of the ammonium sulfate-precipitated globulins an arbitrary protion of the supernatant is discarded and the precipitates with a variable volume of supernatant overlying them are counted in a two-channel gamma spectrometer. The energy spectrum of ^{22}Na is distinctly different from ^{125}I. With the sodium count indicating the volume of supernatant still present and the ^{125}I count the total amount of antigen, the percentage of antigen bound by the antibody can be calculated. (C.H.)

4672 METHOD FOR DOUBLE TRACER STUDIES. Girgis, R. K.; Saif, M.; Bishara, B. A.; El-Kazzaz, S. A. (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo. Inst. of Research for Tropical Medicine, Cairo). Isotope Radiat. Res.; 4: 27-37(Jun 1971).

A method for the discrimination of two radioisotopes, that entails the use of a single-channel pulse height analyzer, was developed. Its use for the in-vivo and in-vitro discrimination of ^{59}Fe and ^{51}Cr or ^{131}I and ^{51}Cr is described. The possibility of the application of the method for the discrimination of any other combinations of two isotopes is stressed and the further possibility of the use of the principle of the method in multiple tracer studies is suggested. The method was found to be reasonably precise and reproducible for double tracer clinical investigations. (auth)

4673 EFFECTS OF RADIATION ON ARTIFICIAL LIPID MEMBRANES. Kay, Robert E.; Bean, Ross C. (Philco-Ford Corp., Newport Beach, Calif.). Advan. Biol. Med. Phys.; 13: 235-53(1970).

In order to study the effects of radiation on cell membranes, models resembling the membranes of living cells were developed. Investigations were conducted on radiation damage to a single membrane structure and the possible receptor function of membranes in detecting and storing radiant energy. The construction of a lipid bilayer membrane is described and illustrated. Experiments were conducted on measurement of change in ion flux across the bilayers before and after the conductance was altered by treatment with excitability inducing material. A table is presented to show membrane potentials induced by internal radioisotope irradiation using $^{24}Na^{+}$, $^{45}Ca^{2+}$, $H^{32}PO_4^{-}$, and $^{131}I^{-}$. Effects of ultraviolet light on membranes containing only α-tocopherol were investigated. No effects were observed in the visible light ranges, but at wavelengths of 290 nm pronounced photopotentials and photocurrents were found. Graphs are presented to show photoelectric responses of the membranes. (H.L.W.)

4674 RADIOIMMUNOASSAY OF URINARY ESTROGENS. Aoki, Takayoshi; Hreshchyshyn, Myroslaw M. (State Univ. of New York, Buffalo). Amer. J. Obstet. Gynecol.; 111: No. 3, 382-5(1 Oct 1971).

A radioimmunoassay for urinary estrogens is described. Following hydrolysis of urine samples, the estrogens are extracted with ether and separated by thin-layer chromatography. Antiserum obtained from rabbits immunized with estradiol-17β-succinyl bovine serum albumin is used in radioimmunoassay. Ammonium sulfate precipitation is employed to separate free and antibody-bound radioactivity. The lower level of sensitivity of radioimmunoassay is 15.6 pg per milliliter for estrone and estradiol-17β and 62.5 pg per milliliter for estradiol. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 4757, 4760, 4845, and 4846.

4675 (BNWL-SA-3971) DISPOSITION OF INHALED ^{239}Pu CITRATE. Ballou, J. E.; Park, J. F.; Morrow, W. G. (Battelle Pacific Northwest Labs., Richland, Wash.). [1970]. Contract AT(45-1)-1830. 15p. (CONF-710919-3). Dep. NTIS.

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971).

Dogs administered oral, intravenous, or inhaled ^{239}Pu citrate were sacrificed from one to 100 days after exposure to compare distribution and retention kinetics. Approximately 0.08% of the oral dose was retained after 3 days, distributed mainly between skeleton (50%) and liver (25%). After intravenous administration ^{239}Pu was retained principally in the liver (32–45% of the dose) and skeleton (29% of the dose) during the 100 day post injection period. Inhaled ^{239}Pu reached a peak concentration in blood after 6 hours and then decreased with clearance kinetics similar to those described by others for dogs and humans administered intravenous ^{239}Pu citrate. The lung, skeleton, liver, blood and intestines retained most of the inhaled ^{239}Pu 1 day after exposure. After 100 days 36% of the initial deposit was retained; 33% in the lung, 44% in the skeleton and 17% in the liver. Plutonium was concentrated by lymphatic tissue following all methods of administration and at all time intervals. Although the concentration in specific lymph nodes (hepatic, splenic, and tracheobronchial) was among the highest of any tissue analyzed, the total amount deposited in a selection of 12 lymph nodes (~10 g tissue) was always less than 0.6% of the body burden. (auth)

4676 (CEA-N-1451) PRELIMINARY EXPERIMENTAL DATA ON THE DYNAMICS OF ^{85}Sr IN ANGUILLA ANGUILLA (L.). Marcoux, Gilles; Foulquier, Luc; Angelier, Eugene; Grauby, Andre (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). May 1971. 14p. (In French). Dep. NTIS (U. S. Sales Only).

The dynamics of the contamination of yellow eels living in natural freshwater labeled with ^{85}Sr were studied over a period of 100 days: both whole-body counting with live specimens and counting with specific organs after dissection were used. It was observed that whereas the reactivity retained by the water was high, that retained by the specimens was proportionately less. The activities of the organs increase at different rates until an equilibrium condition is established. The ^{85}Sr uptake per unit weight is not the same for all organs; the bone tissues, which have the highest concentration factor, absorb proportionately more than the other organs. (France)

4677 (FOA-4-4478) SIMULTANEOUS STUDY ON THE TRANSFER OF RADIOIODINE FROM PASTURE TO MILK AND FROM A SINGLE ORAL INTAKE TO MILK. Auraldsson, Hans-Ake; Ekman, Lars; Ariksson, Ake; Greitz, Ulf (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1971. 7p. Dep. NTIS (U. S. Sales Only).

The relation between a given deposition of ^{131}I on pasture and its concentration in milk from cows grazing on contaminated pasture was studied. The fraction of deposited ^{131}I consumed by the cows can be calculated by comparison with a single oral dose administration experiment. As the secretion of iodine in milk varies with time of season, a simultaneous study of the transfer of iodine from pasture to milk and from a single oral intake to milk was performed using different iodine. In earlier experiments, 6% was found to be consumed. The lower retention can be explained by the characteristics of the grass with considerable straw shooting. Considerable volatilization of ^{131}I occurred in connection with deposition. Approximately 60% disappeared during 18 hrs after deposition and another 6% during the actual grazing period of three days. (auth)

4678 (LF-tr-54) BIOCHEMICAL ASPECT OF THE EARLY ALVEOLARY RETENTION OF LIQUID AEROSOLS OF RARE EARTHS. Pasquier, Ch.; Lefebvre, J. C.; Ehrhart, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by A. A. Horvath for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from report CEA-CONF-1676. 13p. Dep. NTIS.

Biochemical reactions involved in the uptake and retention of rare earth liquid aerosols by the alveola were studied in rats and macaque monkeys using aerosols of ^{140}La chloride as a tracer. Thin layer chromatography of alveolar lipoprotein was used to study the fate of the lipoprotein during respiratory contamination. It was concluded that two physiological reactions are involved in the fixation of rare earth liquid aerosols by the alveola. One reaction involves surface phenomena and the other involves the fixation of cations by lipids or lipoproteins. (CH)

4679 (NYO-3488-1) [DEPOPULATION OF BLOOD BY ^{90}Sr IRRADIATION]. Final Summary Report, December 15, 1965–December 31, 1967. Barnes, Benjamin A. (Massachusetts General Hospital, Boston). 4 Mar 1971. Contract AT(30-1)-3488. 8p. Dep. NTIS.

The feasibility of depopulating the peripheral blood by the continuous extracorporeal irradiation of the blood with a ^{90}Sr radioapplicator was investigated. After preliminary trial work in animals a radioapplicator was designed containing 300 mc ^{90}Sr giving the blood a transient dose in the order of 5 gram-rads. In two patients a profound lymphopenia was obtained by the use of the radioapplicator placed in an artificial arteriovenous shunt at the wrist. Data concerning the depression of the lymphocytes is included in the report. (auth)

4680 EFFECTIVE ANTI-CANCER AGENTS SELECTED BY SUPPRESSION OF ^{131}Cs UPTAKE. Ferguson, Donald J.; Harper, Paul V. (Univ. of Chicago). Ann. Surg.; 174: No. 3, 419-27 (Sep 1971). (CONF-710329-1).

From ninety first annual session of the American Surgical Association; Boca Raton, Fla. (24 Mar 1971).

Common types of human cancers concentrate ^{131}Cs by an active metabolic process. Cesium-131 can be repeatedly measured in superficial metastases with relatively simple equipment, with minor exposure to radioactivity, and without toxicity. Cesium concentration in a metastasis, relative to that in normal tissue, is diminished after a few days of exposure to drugs or hormones which subsequently will produce measurable regression or cessation of growth in that metastasis. By use of the cesium uptake test in suitable patients, it is possible to select effective anticancer agents to obtain an increased rate of objective regression. (auth)

4681 IODOHIPPURATE SODIUM ^{131}I (OIH) CLEARANCE IN MICE BIOASSAY OF RADIOPHARMACEUTICALS. Konikowski, T.; Haynie, T. P.; Glenn, H. J.; Farr, L. E. (Univ. of Texas, Houston). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1343-51 (Sep 1971).

The renal plasma rates and modes of clearance of iodohippurate sodium ^{131}I, ^{169}Yb-DTPA, ^{113m}In-DTPA, and ^{99m}Tc-DTPA have been determined in mice and compared with those of inulin and OIH. The DTPA chelates or complexes of different radionuclides were found to be cleared by the mouse kidney by different pathways at surprisingly different rates. Clearance values were found to be closely reproducible, but should not be compared with values in man or other species. Iodohippurate sodium ^{131}I can be used as a satisfactory clearance standard if it contains less than 1% free iodide in a formulation and concentration not toxic to renal function. The method reported has been shown to be a satisfactory bioassay for evaluating and comparing the clearance of radiopharmaceuticals of similar structure. (auth)

4682 LOCALIZATION OF POLYPEPTIDE CASEIDIN IN THE RENAL CORTEX: A NEW RADIOISOTOPE CARRIER FOR RENAL STUDIES. Winchell, H. S.; Lin, M. S.; Shipley, B.; Sargent, T.; Katchalsky-Katzir, A. (Univ. of California, Berkeley). Contract W-7405-Eng-48. J. Nucl. Med.; 12: No. 10, 678-82(Oct 1971).

The polypeptide caseidin labeled with ^{99m}Tc, using the Fe(III) plus ascorbate method, the Fe(II) method, the Sn(II) method, or labeled with ^{51}Cr localizes in the renal cortex of mice, rats, and dogs. Fifteen minutes after i.v. administration of ^{99m}Tc-caseidin to mice, rats, and dogs approximately one third of the administered activity is in the kidneys and the ratio of activities in the kidney to that in the liver is 4.8:1. Retention of ^{51}Cr activity in the kidney is prolonged following administration of ^{51}Cr-caseidin. In two dogs, sacrificed 51 and 53 days after administration of ^{51}Cr-caseidin, radioactivity in the kidney was 50 and 40% of the activity remaining in the body, respectively. The pattern of retention of activity in mice which were germ free before administration of ^{51}Cr-caseidin was different from that in mice which were not germ free. The rapid accumulation of a large fraction of activity in the renal cortex following administration of ^{99m}Tc- or ^{51}Cr-labeled caseidin suggests the usefulness of caseidin as a radionuclide carrier for renal scintigraphic studies. (auth)

4683 RETENTION OF ^{85}Sr IN RATS CONTAMINATED IN UTERO AND FED WITH THE CONTAMINATED MILK. Jasinski, W. K.; Watras, J.; Gwiazdowska, B. A.; Sapiecha, H. (Inst. of Oncology, Warsaw). Radiobiol.-Radiother.; 12: No. 3, 325-8 (1971).

Results are presented of studies on long-lasting retention of ^{85}Sr in rats contaminated in utero and in rats fed with contaminated milk as compared with ^{85}Sr retention in contaminated mothers. Late retention of ^{85}Sr during the period of 100 to 400 days is marked by constant removal of the nuclide from contaminated animals. The activity of the animals fed with contaminated milk was found to be about four times higher than that of those contaminated in utero. (auth)

Radiation Effects

Refer also to abstracts 4729, 4781, 4785, 4786, 4830, 4885, 4888, and 4896.

4684 (AEC-tr-7233) RADIOBIOLOGY. Translation of Radiobiologiya; 11: No. 1, 3-160(1971). 239p. Dep. NTIS.

Abstracts of the 30 papers in this issue were previously translated and appeared in NSA, volume 25 as numbers 44763-71, 44786-8, 44826-32, 44845, 44883, 44903-7, 44966-7, 44978, and 58031. (E.R.B.)

4685 (AECL-4052, pp 5-18) BIOLOGY. Marko, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 1971.

In Biology and Health Physics Division progress report.

The following research projects in biochemistry and molecular biology were conducted: comparison of RNA molecules in animal cells by oligonucleotide analysis; radiation biochemistry of Escherichia coli; induction of leukemia in rats; repair of DNA in bacteria; and enzymatic repair of uv and x radiation damage to DNA in bacteria and yeast. The following research projects in genetics, development, and population studies were conducted: genetic control of radiosensitivity in Schizosaccharomyces pombe; replicating instabilities in Schizosaccharomyces pombe; preparation and study of spheroplasts from stationary phase cells of S. pombe; liquid holding recovery and spontaneous cell death in the normal and radiosensitive strains of S. pombe; the frequency of rII deletion mutations among suppressors of an amber mutation in gene 30 of bacteriophage T4D; radiation genetics in insects (Dahlbominus); radiation injury in Rhodnius; and radiation studies on biting flies. (H.L.W.)

4686 (JAERI-1208) CALCULATION OF SURVIVAL RATES AND EFFECTIVE INACTIVATION CROSS SECTIONS OF TARGETS FOR FAST NEUTRONS BASED ON MICRODOSE CONCEPT. Numakunai, Takao; Ohtani, Satoru; Kawai, Katsuo; Oda, Nobuo (Japan Atomic Energy Research Inst., Tokyo). 8 Oct 1970. 20p. Dep. NTIS (U. S. Sales Only).

The survival rates and the effective DNA inactivation cross sections of biological targets for neutrons of energies 1 to 20 MeV were calculated according to the target theory based on the microdose concept, using an IBM-7044 computer. The survival rates were calculated with one-, two- and three-events models for different combinations of the following parameters: the incident energy of fast neutrons, the cut-off energy of delta-rays, and the average thickness of targets. The effective inactivation cross sections of targets were derived from the survival rates for one-target model. (Japan)

4687 (NYO-2798-62) ULTRAVIOLET IRRADIATION OF NUCLEIC ACIDS AND RELATED COMPOUNDS. Annual Progress Report, September 1970–August 1971. Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. Dept. of Biochemistry). Sep 1971. Contract AT(30-1)-2798. 8p. Dep. NTIS.

Progress is reported on isolation and structural determination of biologically important pyrimidine adducts. Properties of thymine phototrimers and cytosine-cytosine adduct are discussed; structural characterizations are based on ultraviolet, infrared, and mass spectra data. Reaction mechanisms are discussed with regard to photochemical reactions occurring with charge transfer complexes, transition states, and mechanism of hydrogen abstraction from the methyl group of thymine. Development of techniques for field ionization mass spectrometry and fluorescence spectrometry is discussed. (H.L.W.)

4688 (NYO-3797-19) PROGRESS REPORT, JULY 1, 1970–AUGUST 15, 1971. Freifelder, David (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3797. 5p. Dep. NTIS.

Studies on the effects of thymine starvation on Escherichia coli led to the conclusions that DNA ligase activity is normal in starved cells; that an endonuclease activity is strongly stimulated; and that an exonuclease activity is weakly stimulated. Electron microscope studies were conducted on the effects of the intercalating dye, ethidium bromide, on DNA and this instrument was also used in studies on conversion of linear to circular λ DNA. Studies were continued on position of single-strand breaks in DNA of bacteriophage λ; it is suggested that the breaks are normally sealed by ligase but persist at low pH. Studies on base damage in x-irradiated DNA of phage λ demonstrated that the oxygen-dependent x-ray damage prevents expression of λ genes which are injected but which only require transcription for expression. It was concluded that base damage was lethal because it blocks transcrip-

tion. Progress is also reported on mechanisms of lysogenization and induction of phage λ. (H.L.W.)

4689 (NYO-4249-1) MOLECULAR EVENTS BASIC TO CELLULAR RADIATION RESPONSE. Progress Report, January 1, 1971-December 31, 1971. Kolodny, Gerald M. (Massachusetts General Hospital, Boston. Radiology Research Lab.). Contract AT(30-1)-4249. 22p. Dep. NTIS.

Research on several interrelated areas significant to the understanding of cell division and the effect of radiation on cell division is reported. A new inhibitor of cell division, sodium chloroiridate, which stops DNA synthesis without blocking RNA and protein synthesis, and results in very large giant cells; the effects of x irradiation on the transfer of macromolecular RNA between untransformed 3T3 cells and between virally transformed cells; and evidence for intercellular transfer of representatives of the major species of cytoplasmic RNA are discussed. Examination of the RNA secreted by cells in culture into the media showed a 5 to 10s RNA which was highly methylated, with a methylation pattern quite different from ribosomal or transfer RNA. Investigations into the effects of various inhibitors on 3T3 cell adhesion showed that of all the inhibitors used, only colchicine and decreased temperature affected the readhesion of trypsinized cells to new culture surfaces. (41 references.) (auth)

4690 (ORO-4183-14) CHEMICAL EFFECTS OF IONIZING RADIATIONS ON THE INDIVIDUAL AMINO ACIDS WITHIN INTACT AND PURE PROTEIN MOLECULES. Annual Progress Report for the Period Beginning February 1, 1971. Friedberg, Felix (Howard Univ., Washington, D. C. Dept. of Biochemistry). 30 Oct 1971. 5p. Dep. NTIS.

Ribonuclease, mixed with aspartic acid or cystine, lyophilized and exposed to ^{60}Co γ radiation, binds these amino acids covalently. The percent amino acid bound is approximately five times greater for cystine than for aspartic acid. Thus, polymer formation upon irradiation of dried protein probably results mainly from the generation of intermolecular carbon bonds. (auth)

4691 (SZS-7/71) BIOCHEMICAL CHANGES IN BLOOD AND URINE INDICATING RADIATION DAMAGE. A Literature Review. Part I. Solle, M.; Orban, U. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

A review is presented of 167 publications on radiation induced changes of the concentration of metabolites in blood and urine of several mammals and of humans. The literature was evaluated from the viewpoint of the assessment of these changes, i.e., the so-called biologic dosimetry. The present part contains data on amino acids and some of their metabolites (taurine, metabolites of tryptophan, creatine, metabolites of nucleic acids, deoxyribosides, β-amino isobutyric acid, pseudouridine, and purines) and mineral substances. (auth)

4692 MODIFICATION OF THE EFFECTS OF RADIATION ON AMOEBAS. I. SENSITIZING ACTION OF ACTINOMYCIN D BEFORE GAMMA IRRADIATION. Skreb, Yvette; Horvat, Durda (Institut de Recherches Medicales et de Medecine du Travail, Zagreb). Int. J. Radiat. Biol.; 20: No. 2, 129-35 (1971). (In French).

Treatment with actinomycin D or gamma-radiation produced a strong inhibition of RNA and protein synthesis in nucleate and anucleate amoeba fragments. The inhibitory effect was more pronounced in nucleate fragments, particularly in the nucleus itself. If actinomycin D were applied before irradiation, anucleate fragments became incapable of any synthesis and nucleate fragments metabolized weakly. This effect was attributed to the nuclear DNA which, though irradiated, was still capable of transmitting information and even playing a reparative role. The role of the amoebic cytoplasmic DNA, however, remained obscure. (UK)

4693 EFFECTS OF X IRRADIATION AND/OR BAL (1,2-DIMERCAPTOPROPANOL) ON ACTIVITY AND STRUCTURE ON BEEF LIVER CATALASE. Nette, Peter Hans. Iowa City, Iowa; Univ. of Iowa (1971). 75p. University Microfilms Order No. 71-22,070.

Thesis.

UV absorption spectroscopy and electron spin resonance (ESR) spectroscopy were used to investigate the effect of x irradiation and BAL (1,2-dimercaptopropanol) on the activity and structure of beef liver catalase in aqueous solution. It was shown that the irradiation inactivated the enzyme via an indirect effect. Catalase also was inactivated to some extent by BAL. BAL (10^{-8} M) protected catalase (4.88×10^{-9} M) against radiation-induced inactivation when present during exposure. Optical absorption measurements at 405 nm revealed that both BAL and x irradiation altered the heme group of catalase. The chemical reaction of BAL with the heme group appeared to be a temporary binding to the prosthetic group and a reduction of the iron center. There was a proportionality between the amount of BAL temporarily bound to the enzyme and the radioprotective effect. Therefore, BAL apparently did not afford its protective power by simply acting independently with regard to radical scavenging. The OD_{405} of catalase was decreased in proportion to the radiation dose. BAL present during irradiation enhanced this effect. The combination, however, was less than completely additive. The OD_{405} recovered asymptotically with time after irradiation with or without BAL. A mathematical model was constructed for the recovery curves and showed that the probability of recovery per unit time was dose independent and was also independent of the amount of BAL present. Because of experimental difficulties, Cu^{2+} was used as a substitute for Fe^{3+} of catalase in further investigations of a mechanism of action for the radioprotective effect of BAL. ESR spectra and spectrophotometric measurements of mixtures of BAL and Cu^{2+} solutions were used to substantiate the conclusion that BAL forms a temporary complex with catalase at its iron center with the iron in the divalent state. From these results a possible mode of action for radiation damage of catalase and the radioprotective effect of BAL has been proposed. Radiation induced reduction of the iron center rendered catalase inactive. BAL also reduced the iron by forming a complex with catalase. Radiation, in this instance, caused a reoxidation of the complex resulting in a reactivation or release of active catalase. Some implications of this model are discussed. (Diss. Abstr. Int., B)

4694 TEMPERATURE DEPENDENCE OF RADIATION SENSITIVITY IN THE DRY STATE. III. INVESTIGATIONS WITH ISOLATED INFECTIOUS φX174-DNA. Wintermantel, G. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 20: No. 4, 347-54(1971).

The effects of ionizing radiation on macromolecules and biological systems in the dry state can be described as a function of temperature by three terms, one being independent of temperature, the other two having apparent activation energies of 1 kcal/mole and 4 to 6.5 kcal/mole, respectively, which are due to the action of radiation-induced radicals. In earlier work, no temperature-dependent component with an activation energy of 1 kcal/mole was reported for the radiation damage on isolated infectious φX174-DNA. Therefore, inactivation of infectious φX174-DNA by atomic hydrogen was determined at various temperatures. Freeze-dried DNA samples were exposed to H atoms liberated from a thin polyvinyl formal foil by 30 keV protons, foil and samples being maintained at the same temperature during the exposure. The influence of temperature on the sensitivity of infectious φX174-DNA molecules towards the action of hydrogen atoms is represented by the relation $S(T) = c \cdot \exp(-E_1/RT)$ with $E_1 = (0.91 \pm 0.07)$ kcal/mole. A corresponding component with $E_1 = (0.97 \pm 0.1)$ kcal/mole could be derived from our experimental data obtained after ionizing irradiation of highly-purified DNA samples at various temperatures. The results support the interpretation that the temperature-dependent part of the inactivation rate, characterized by an apparent activation energy of about 1 kcal/mole, is the result of the action of radiation-induced hydrogen atoms. (auth)

4695 RADIOBIOLOGICAL INVESTIGATIONS IN CEREALS. VI. EPR MEASUREMENTS IN SINGLE CARYOPSES OF WHEAT. Walther, F.; Haug, A. (Michigan State Univ., East Lansing, Mich.). Contract AT(11-1)-1338. Radiat. Bot.; 11: No. 5, 347-54(Oct 1971).

Characteristic properties of free radicals in the different parts of caryopses of wheat were determined at room temperature with electron paramagnetic resonance (EPR) techniques, using single caryopses or samples of 10 to 20 isolated embryos. The seed coatings and the embryo each contained a characteristic narrow endogenous radical signal. After γ-irradiation of the caryopses, the peak-to-peak width of these narrow signals remained constant but a new, broad signal was induced in the endosperm at higher doses obscuring the narrow signals. At low doses the induced radical content per unit weight was about 50% higher in the embryo than in the endosperm or in the seed coatings. A possible relationship between radiation induced radicals and radiation damage is discussed suggesting radical migration as a working hypothesis. (auth)

4696 FREE RADICALS PRODUCED BY IONIZING RADIATION IN BONE AND ITS CONSTITUENTS. Houben, J. L. (Univ., Liege). Int. J. Radiat. Biol.; 20: No. 4, 373-89(1971).

To study the distribution of free radicals produced by ionizing radiations in bone, the influence of different parameters (Ca/P ratio, crystalline structure, influence of impurities, molecular weight) on the production and stabilization of free radicals in synthetic apatitic crystals and collagens was investigated at room temperature and -180°K. Whole bone and fractions of different densities were irradiated in air and in vacuum and the yields of the different types of radicals were studied. The following observations were made: the nature of the free radicals in the or-

ganic phase depended on the density; the yield in apatite-like radicals increased with the density; bone presented an increase of the radiosensitivity of the collagen and of the radioresistance of the mineral phase as compared with its isolated components; toluene produced radicals in unirradiated bone, the nature and the concentration of these radicals depending on the density. Annealing after irradiation in liquid nitrogen was also studied. Possible identifications of the nature of the free radicals observed are presented. (auth)

4697 EXAMINATION OF CARBOHYDRATE METABOLISM AND OF THE SIZE OF LEUKOCYTES UNDER THE INFLUENCE OF IONIZING RADIATION. Gerhardt, P. (Univ., Tuebingen, Ger.). Radiobiol.-Radiother.; 12: No. 3, 347-52(1971). (In German).

The activities of the glycolytic ferments G-6-PDG and 6-PGDH of the leukocytes of irradiated and unirradiated rabbits as well as of therapeutically irradiated patients were measured. The size of granulocytes and of lymphocytes was also determined. The examinations yielded an increase of ferment activities and an increase of the size of granulocytes with increasing leukopenia. These results are valued as a sign of a compensatory balance in cell formation of the bone marrow with radiation-induced leukopenia. (auth)

4698 RADIOCHEMICAL CHANGES IN THE PYRIMIDINE BASES OF NUCLEIC ACIDS. Jaszsagi-Nagy, Eva (Univ., Budapest). Radiobiol.-Radiother.; 12: No. 3, 311-18(1971).

Various photochemical reactions take place in the pyrimidine bases of nucleic acids as a result of uv and ionizing radiation. The dimerization of the thymine base occurring in DNA is the lesion that shows the most constant character. The author has studied whether the pyrimidine reactions to irradiation observed in vitro can be demonstrated in bacteria also in vivo. It was found that the photochemical products forming at the irradiations of aqueous DNA solution and in DNA isolated from an irradiated bacterium culture are the same as were recorded at the irradiation of the bases. It would seem that the mutagenic and lethal effect of uv in the case of bacteria is mainly the result of the dimerization of the thymine molecule. In the case of x rays, the inactivation of DNA is one of the most important, but not the exclusive cause of the physiological inactivation of the cell. (auth)

Immunology

4699 (NYO-3749-2) EFFECT OF IONIZING RADIATION ON THE SUSCEPTIBILITY AND IMMUNITY TO PARASITIC INFECTIONS. Final Summary Report, July 15, 1966–July 14, 1968. Coleman, Robert M. (Boston Coll., Chestnut Hill, Mass.). Contract AT(30-1)-3749. 4p. Dep. NTIS.

Studies on the effects of x radiation on lysine incorporation by the tapeworm, Hymenolepis nana, showed that there was a significant difference in the uptake of ^{14}C-labeled lysine by the mitochondrial and microsome fractions of the irradiated and unirradiated worms. No difference was found in the uptake by the nuclear and soluble protein fractions. Studies on rats infected with Trypanosoma lewisi showed that administration of 6-mercaptopurine on day four of a previously untreated infection significantly reduced the level of parasitemia. In salicylate treated hosts there was no increase in the number of trypanosomes within the 24 hr period following injection of mercaptopurine on day four of the infection. When hosts were exposed to x radiation 24 hrs prior to parasite inoculation and first administered mercaptopurine on day four of the infection, there was a significant depression of the parasitemia within 48 hrs. Studies were conducted on secondary immune response to soluble and particulate antigens in irradiated and non-irradiated mice. Results indicated that it is the form rather than the nature of the antigen that accounts for variation in radiosensitivity. (H.L.W.)

4700 SYNERGISM IN IMMUNOSUPPRESSION. II. EFFECT OF SPLENECTOMY ON SUPPRESSION OF TETANUS ANTITOXIN PRODUCTION INDUCED BY METHYLPREDNISOLONE, AZATHIOPRINE, CHLORAMBUCIL, AND RADIATION. Gelfand, Michael C.; Friedman, Eli A.; Knepshield, James H. (Walter Reed Army Hospital, Washington, D. C. State Univ. of New York, Brooklyn). Transplantation; 12: No. 4, 310-13(Oct 1971).

An in vivo assay of tetanus antitoxin production in the mouse was utilized to evaluate the effect of splenectomy on treatment with immunosuppressive drugs and/or whole-body radiation. Methylprednisolone, azathioprine, chlorambucil, and 100 rads of ^{60}Co radiation were administered as single, double, triple, or quadruple agents to splenectomized and intact mice. For both intact and splenectomized mice, the administration of two agents produced greater immunosuppression than one agent and three agents greater than two agents. Treatment with all four agents resulted in the highest percentage of animals with depressed antibody synthesis. Splenectomy reduced antitoxin production and significantly potentiated the immunosuppressive effect of each agent when administered alone. Splenectomy did not increase significantly the immunosuppressive effect of two, three, or four agents in combination therapy. (auth)

4701 PROLIFERATION OF DONOR HEMATOPOIETIC CELLS IN IRRADIATED AND UNIRRADIATED HOST MICE. Takada, Yumiko; Takada, Akikazu (New York State Dept. of Health, Springville, N. Y. State Univ. of New York, Buffalo). Transplantation; 12: No. 4, 334-8(Oct 1971).

The present study indicates that the irradiated marrow quickly receives stem cells from the unirradiated area (possibly marrow), and thus becomes a chimera. Migration of stem cells from the unirradiated area prevented exclusive proliferation of donor cells in the irradiated marrow. There have been a number of findings that indicate cell to cell interactions in immune response. The present study indicates the possibility of cellular interactions in the regulation of hematopoiesis. (auth)

4702 MEASUREMENT OF MEDROXYPROGESTERONE ACETATE (PROVERA) BY RADIOIMMUNOASSAY. Cornette, J. C.; Kirton, K. T.; Duncan, G. W. (Upjohn Co., Kalamazoo, Mich.). J. Clin. Endocrinol. Metab.; 33: No. 3, 459-66(Sep 1971).

A double antibody radioimmunoassay is described which is capable of detecting 100 pg of medroxyprogesterone acetate (Provera) in 0.1 ml of unextracted serum. The antibody was produced to steroid conjugated at the 3 position with bovine serum albumin. The side groups attached at 17 and 21 positions are more important determinants of antibody specificity than groups attached at 6. No significant cross-reactivity was noted with physiological concentrations of naturally occurring steroids. The concentration of Provera in peripheral serum was determined for female monkeys and humans that received the drug by various routes of administration. A rapid decrease to less than one half the initial concentration was noted within 10 min after an intravenous injection. Blood levels were maximum at 2 or 4 hr after oral administration. Intramuscular injection resulted in fluctuating blood levels that were maximal at 2–15 days post injection. Following insertion of a Provera silastic vaginal device, consistently low blood levels were found during the 21 days that the device was in place. (auth)

4703 RADIOIMMUNOASSAY FOR TRIIODOTHYRONINE (T_3). I. AFFINITY AND SPECIFICITY OF THE ANTIBODY FOR T_3. Gharib, Hossein; Ryan, R. J.; Mayberry, W. E.; Hockert, T. (Mayo Clinic and Mayo Foundation, Rochester, Minn.). J. Clin. Endocrinol. Metab.; 33: No. 3, 509-16(Sep 1971).

The free acid form of L-triiodothyronine was coupled to HSA, BSA or RSA using carbodiimide. The conjugates contained 11, 17 moles of T_3 per mole of protein. Rabbits were immunized separately with each conjugate. Antibodies against T_3 were obtained in all animals after 6 weeks of immunization. One antiserum prepared with T_3-HSA was studied in detail using a radioimmunoassay procedure. It was useful in a final dilution of 1:1000 to 1:4000 and was sufficiently sensitive to measure 50 pg of unlabeled T_3 per assay tube. The ability of 30 tyrosine and thyronine derivatives to compete with T_3 for binding to antibody were investigated to assess the specificity of the assay. Antibody recognition involved the following structural requirements: two phenolic rings; a 3′ iodine; a 4′ hydroxyl group and a 5′ hydrogen. Alterations in the alanine side chain reduced antibody recognition, but to a much smaller extent than changes in the structure of the phenolic rings. Thus, the antiserum is highly specific for L-T_3 and its alanine side chain derivatives. Preliminary results obtained with measurements of T_3 in human serum are given. (auth)

Ecology

Refer also to abstracts 4379, 4381, 4676, 4685, 4737, 4738, 4740–4748, 4752, 4754, 4759, 4838, 4839, 4866, and 6313.

4704 (A/CONF.49/P-652) PUBLIC HEALTH IMPLICATIONS OF RADIOACTIVE WASTE RELEASES. (World Health Organization, Geneva (Switzerland)). Aug 1971. 12p. (CONF-710901-515). Dep. NTIS.

From fourth international conference on the peaceful uses of Atomic Energy; Geneva, Switzerland (6 Sep 1971).

At present, the radiation doses resulting from the release of radioactive materials from peaceful uses of atomic energy are known to be small compared with those from other natural and

man-made sources of exposure and fall well below the standards recommended by accepted international authorities. Nevertheless, in view of the anticipated expansion of the nuclear industry in the near future it is necessary that strict controls over effluents be exercised. It is desirable to draw the attention of the public health authorities to the possible effects of, and the action needed to counteract, the radioactive contamination of the environment that may result from such expansion. Preliminary estimates indicate that, of the various peaceful applications of nuclear energy, power production is by far the largest source of environmental radioactive contamination. This is so at present, and will be even more so in the future. Electric power production is expected to grow from its present 24 gigawatts (GW) to about 4260 GW by the year 2000. This almost 200-fold increase in so short a time calls for continuing action to ensure that the delicate ecological balance of the world is not upset. Estimates are presented of the radiation dose to the world population that may be expected in the year 2000 from the nuclear power industry and from the radionuclides produced by it. It was estimated at about one per cent of the average dose due to natural background radiation. This contribution is small in comparison with that caused by variations in the cosmic radiation from outer space due to differences in elevation or by terrestrial radiation from natural substances on the earth. It must be realized, however, that the calculations are only of order of magnitude. The available data are very meagre and often not representative of future releases by the nuclear industry, which depend on the technology used at each plant; dilution factors vary from place to place; population distributions also vary; and methods of dose calculation are liable to change as new data are obtained. The estimates may therefore be in error by a factor of as much as 10 or more. The attempt to predict the radiation doses to man from worldwide ^{129}I, ^{85}Kr, and ^{3}H in the year 2000 has provided only order of magnitude estimates because: each of these radionuclides offers many problems in dosimetry which are often outside the orthodox health physics formulations; the natural environmental levels of these nuclides and the changes induced in those levels by atmospheric weapons testing and/or production reactors are for the most part poorly documented; and dependable qualitative, much less quantitative, data on the distribution-dilution-progression-fate characteristics of each of these three radionuclides are not available and must be presumed or guessed at. (auth)

4705 (AECL-3951) EFFECTS OF IONIZING RADIATION ON FOREST TREES: A REVIEW. El-Lakany, M. H. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1971. 76p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

The radiosensitivity of forest trees is reviewed along with the physiological, morphological, and genetic effects of x radiation on various developmental stages. These include seeds, seedlings, mature plants, reproductive structures, and pollen grains. The utilization of induced mutation in forest tree breeding and the ecological effects of radiation, which have recently gained considerable attention, are examined separately. A total of 202 references are cited and an index is included to facilitate obtaining specific species information. (auth)

4706 (AECL-4052) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, APRIL 1-JUNE 30, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 57p. (PR-B-90). Dep. NTIS (U. S. Sales Only). AECL $1.50.

Separate abstracts were prepared for the four sections of this report. (H.L.W.)

For abstracts of individual sections see: 4685, 4707, 4750, and 4864.

4707 (AECL-4052, pp 25-36) ENVIRONMENTAL RESEARCH BRANCH. Mawson, C. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 1971.

In Biology and Health Physics Division progress report.

Progress is reported on the following projects: off-site monitoring of samples from the Ottawa River for ^{137}Cs and ^{90}Sr; radiochemical analysis of the Liquid Disposal Area; liquid effluent monitoring of CRNL environs; release of tritium to the Ottawa River; uptake of ^{60}Co by edible plants; and fate of radionuclides in aquatic communities. The following studies were conducted on Perch Lake Basin: radioecological studies; International Hydrologic Decade program; trace elements in water; underground movement of radionuclides; atmospheric diffusion; and Perch Lake evaporation study. Productivity and nutrient studies included carbon-14 tracer studies and the use of experimental water columns in determining species diversity and concentrations of phytoplankton in Maskinonge Lake. The design of a gamma ray counting system is described and modifications were made in the methane proportional counter for the low background beta ray counting system. (H.L.W.)

4708 (BMI-171-131) STUDIES OF THE AVIFAUNA ON AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1969-June 30, 1970. Williamson, Francis S. L.; Emison, William B.; White, Clayton M. (Battelle Memorial Inst., Columbus, Ohio). Mar 1971. Contract AT(26-1)-171. 42p. Dep. NTIS.

Data for the prediction and assessment of the effects of underground nuclear tests on the birds on Amchitka Island, Alaska, and to recommend actions to minimize any potential deleterious effects to the avifauna are presented. Information is presented on the status and distribution of 89 avian species on Amchitka during 1969 to June 1970, their density, breeding biology, and migration patterns. Estimates were made of population size of the 27 species known to have bred on Amchitka in 1969. Studies on density, reproduction, distribution, mortality, population structure, migration, foods, and pesticide levels were also made on two endangered species, the peregrine falcon and bald eagle. Immediate effects of the 1969 nuclear test on the Amchitka avifauna were minimal, with only slight damage to the habitat and nesting sites. (auth)

4709 (BMI-171-141) BIOENVIRONMENTAL-EFFECTS PREDICTIONS FOR THE PROPOSED CANNIKIN UNDERGROUND NUCLEAR DETONATION AT AMCHITKA ISLAND, ALASKA. Kirkwood, James B.; Fuller, R. Glen (Battelle Columbus Labs., Ohio). Oct 1971. Contract AT(26-1)-171. 31p. Dep. NTIS.

The effects of Cannikin underground nuclear explosion on the environment and biota in the terrestrial, freshwater, and marine ecosystems of Amchitka are predicted to be of somewhat greater magnitude than the effects of Milrow. However, no plant or animal population is expected to be endangered. These predictions are based on the assumption that the Cannikin detonation will occur in the autumn, and that predictions of ground shock and underwater pressure changes supplied by AEC-NVOO are essentially correct. Cannikin is expected to affect terrestrial habitats over a larger area than Milrow did; small rock falls and turf slides are predicted along several miles of coastline. However, the total amount of material involved is not considered likely to be of ecological consequence, since no single large falls are predicted. Bald eagle nesting sites and peregrine falcon eyries occupied in 1971 are not likely to be destroyed, although one or two eagle nesting sites and one falcon nesting site may be rendered unusable. Population densities, distributions, and reproductive potentials of these species are not expected to be significantly affected. Other avian populations should not be threatened. Some fraction of the fish in freshwater streams and lakes near Cannikin surface zero may be killed, but otherwise effects in the freshwater ecosystem will be minor. Combining the relevant estimates yields a prediction that perhaps 20 to 240 sea otters might be exposed to overpressures severe enough to rupture their eardrums and ultimately result in their death, but past observations on the effects of harvest and transplant removals from the populations suggest a loss of this magnitude would have no long-range effect on population. Populations of other marine mammals (Steller's sea lions and harbor seals) will also be unaffected. Fish populations in the marine environment will not be endangered, although sizable numbers of individuals of Pacific cod and some rockfish species may be killed if the "worst credible" predictions prove correct. Small intertidal bench areas may be disrupted, but succession and recolonization will be expected to restore the biota of such areas, and effects on food webs in the marine environment will be minimal. No adverse effects of ecological consequence are expected in the marine ecosystem around Amchitka. (auth)

4710 (CEA-R-4168) STUDY OF ^{106}Ru MIGRATION IN SOILS. Amy, Jean-Paul (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb 1971. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Nancy Univ. (France). Faculte des Sciences.

The migration of ^{106}Ru in soils was studied; two solutions of nitrosylruthenium complexes (state in which ^{106}Ru is released from the Marcoule plant) and a noncomplex ruthenium chloride solution were used in experiments on the mobility of the radioelement, the solutions being percolated through columns containing the soils. The migration depended on the degree of ionization: anionic forms were found to be mobile in the soil, a large fraction being found in the percolate, whereas cationic states were sorbed much more quickly. The nature of the soil also affects the migration process: Ru migrated deeply in sandy soils, whereas it was strongly sorbed by the muddy fractions of soils with a mud sand texture. The mobility of Ru in the soils studied was found to be more dependent on the solution percolation rates than on the particle size distribution, these two factors are, however, closely related. (France)

4711 (CONF-710818-2) DYNAMICS OF THE FORAGE-COW-MILK PATHWAY FOR TRANSFER OF RADIOACTIVE IODINE, STRONTIUM, AND CESIUM TO MAN. Booth, R. S.; Burke, O. W.; Kaye, S. V. (Oak Ridge National Lab., Tenn.). [1971]. 17p. Dep. NTIS.

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

A systems analysis model was developed to predict the time-dependent concentration of ^{90}Sr, ^{137}Cs, and ^{131}I in the milk, meat, and soft tissue of cows that forage a pasture contaminated by fallout. The variables in this model are adjustable to a wide variation in weather conditions, ecological conditions, and countermeasures. Simulated concentrations were based on reasonable, conservative parameters derived completely from published measurements. There was continued contamination of the milk and meat several weeks after a short-term deposition on the grass (radioactive cloud above the pasture for one hr). However, the concentration in milk was in transient equilibrium with the grass (a 14-day environmental half-time for loss of radioactivity from the grass was specified) within a week after the deposition, and the majority of man's uptake of radioactivity from consumption of milk and meat was accomplished within the first few weeks after deposition. The transfer of radioactivity to man was almost exclusively via the direct grass to cow gut to cow blood (body fluid) to meat and to milk pathway. The predicted equilibrium concentrations indicate the potential uptake by man from a continuous source of radioactivity above the pasture. The influence of environmental conditions and countermeasures was studied. If, for example, the cows were moved from the contaminated pasture one day after an impulse source to the grass, the cumulative meat and milk concentration would be only 5% of that obtained when no countermeasures are applied. (auth)

4712 (HEDL-SA-276) SOURCE MAP DEVELOPMENT FOR USE IN PREDICTING RADIOLOGICAL EFFECTS OF NUCLEAR FACILITY OPERATIONS. Wise, K. R. (Hanford Engineering Development Lab., Richland, Wash.). [1970]. Contract AT-(45-1)-2170. 37p. (CONF-711106-1). Dep. NTIS.

From Air pollution control meeting; Calgary, Alberta, Canada (22 Nov 1971).

Computer models (HERMES) were developed for use in estimating the radiation dose to man in the year 2000 contributed by the operation of nuclear power plants. Nuclear facility requirements for the year 2000 were forecasted by means of an existing computer code. The siting of the projected nuclear facilities was assumed to be consistent with known siting criteria. Six interdependent subelements of the model were developed to predict: regional electrical energy production requirements and the facility requirements to satisfy the demand; the radioisotope effluent inventory associated with each nuclear facility; a nuclear facility source map; a receptor location and population density map; source-to-receptor (man) transport mechanisms; and calculations of the radiation dose to man as a function of radioisotope and physiological interactions. (C.H.)

4713 (JUL-779-RG) PROBLEMS OF ENVIRONMENTAL PROTECTION: THEIR EXPANSION AND IMPORTANCE. Froehling, Werner (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jun 1971. 27p. (In German). Dep. NTIS (U. S. Sales Only).

The importance of five subjects frequently mentioned in connection with environmental problems is discussed: pollution of air and water, contamination by pesticides, waste removal, and the importance of radioisotopes released from nuclear power plants. (auth)

4714 (NVO-269-13) FALLOUT RADIONUCLIDES IN PACIFIC OCEAN TUNA. Held, Edward E. (Washington Univ., Seattle. Lab. of Radiation Ecology). 10 May 1971. Contract AT(26-1)-269. 16p. (CONF-710501-36). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Samples of light and dark muscle from tuna obtained in 1968 and 1969 from the Japanese tuna fishery in the Pacific, and the same tissues plus liver from tuna from the vicinity of Bikini Atoll were analyzed for gamma-emitting radionuclides, iron-55 and stable iron. Tuna from the southern hemisphere tended to have lower concentrations and more specific activities than tuna from the northern hemisphere. There were no significant trends in the data when ^{55}Fe specific activities were compared with species, month of catch, location of catch, or size of fish. There was a close correlation of ^{55}Fe specific activity in light muscle, dark muscle and liver and of ^{55}Fe concentration between dark muscle and liver. Yellowfin tuna caught near Bikini Atoll contained ^{60}Co believed to be derived from the atoll. There was a close correlation of ^{60}Co concentrations between dark muscle and liver. Cesium-137 concentrations were lower than those reported for fish from middle and northern latitudes by three to five orders of magnitude. (auth)

4715 (NYO-2174-132) ECOLOGICAL ASPECTS OF PLUTONIUM DISSEMINATION IN AQUATIC ENVIRONMENTS; WHAT HAS Pu DATA TO TELL US ABOUT OTHER TRANSURANICS. Noshkin, Victor E. (Woods Hole Oceanographic Institution, Mass.). [1971]. Contracts AT(30-1)-2174; AT(30-1)-4275. 31p. (NYO-4275-1; CONF-710919-2). Dep. NTIS.

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971).

The available data concerning the dissemination of plutonium and other transuranics in the aquatic environment are summarized. The most studied isotope has been ^{239}Pu derived from worldwide fallout. Essentially all the published work has been concerned with levels in the marine environment where plutonium is found widespread among planktonic, pelagic and benthic organisms. The concentrations are higher in organisms feeding on sediment or on surfaces than in those drawing largely on the water itself. Among the species where data are available are a variety of convenient indicator organisms for plutonium. There is some evidence that plutonium concentrations are increased in organisms of higher trophic levels. Bone and liver are major repositories for plutonium in marine vertebrates while muscle tissue of both marine vertebrates and invertebrates contain relatively lower concentrations. Plutonium is geochemically separated from both ^{90}Sr and ^{137}Cs in the water column and the sedimentation of ^{239}Pu may be more involved with biological processes than has been found for fallout rare earth isotopes. In marine sediments, as in soils, plutonium is more mobile than was originally expected. What little is known of the behavior of plutonium in the marine environment should be used conservatively to assess the behavior and distribution of new plutonium additions derived from sources other than fallout, and even more conservatively in predicting the impact of other transuranics in the aquatic environment. Considerably more understanding of the aquatic radioecology of several of the elements is a major priority especially since it now appears that when the relative biological effectiveness of α vs γ or β radiations is considered, fallout ^{239}Pu contributes more than fallout ^{90}Sr or ^{137}Cs to the artificial radiation exposure of many marine species. (auth)

4716 (RISO-246) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1970. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1971. 21p. Dep. NTIS (U. S. Sales Only).

Measurements of fallout radioactivity in the Faroes in 1970 are presented. Strontium-90 and ^{137}Cs (in most instances) were determined in regularly collected samples of precipitation, grass, milk, lamb, fish, seawater, bread, and drinking water. In addition, analyses of spot samples of potatoes, sea plants, birds, whale meat, vegetables, eggs, and human bone were carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1970 are given. (auth) (Denmark).

4717 (SR-639-11) FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM. Progress Report, January 1, 1971-December 30, 1971. (Georgia Univ., Athens. Dept. of Zoology). Contract AT(30-1)-639. 17p. Dep. NTIS.

Mathematical models were developed for use in computer calculations of the transport flux of radioisotopes through a salt marsh ecosystem. The models were adapted for use with the IBM Scientific Subroutines RKSS and DRKGS for the 360/365 computer. The validity of the model was tested using calculations of the transport of P from marsh water through cord grass (Spartina alterniflora), detritus, detritus feeders, and back to water under eight different sets of initial ecological conditions. Preparations for testing the models under field conditions are described. (CH)

4718 (SRO-310-1(Pt.1)) SAVANNAH RIVER ECOLOGY LABORATORY. Annual Report, 1971. Beyers, Robert J.; Brisbin, I. L.; Coleman, D. C.; Gentry, J. B.; Gibbons, J. W.; Smith, M. H. (eds.) (Georgia Univ., Athens. Inst. of Ecology). Aug 1971. Contract AT(38-1)-310. 193p. Dep. NTIS.

Progress is reported on the following research projects: effects of stress on a simple laboratory microecosystem; winter response of largemouth bass (Micropterus salmoides) to heated effluent from a nuclear reactor; effects of chronic gamma irradiation on the fish, Oryzias latipes; relationships between standing crop and nutrient quality of aquatic macrophytes; variation in the elemental content of the water hyacinth, Eichhornia crassipes; carnivorous pathway of phosphorus uptake by the bladderwort, Utricularia inflata; the role of the southern harvester ant, Pogonomyrmex badius, in old-field mineral nutrient relationships; ele-

mental composition of largemouth bass (Micropterus salmoides); abundance and local movement of largemouth bass in a reservoir receiving heated effluent from a reactor; responses of broiler chicks to gamma radiation exposures: changes in body composition and caloric density; food as a limiting factor in the population ecology of the old-field mouse, Peromyscus polionotus; use of radioactively tagged bait to study movement patterns in small mammal populations; radioactive isotopes in studies of population dynamics of small animals; yearly fluctuations in small mammal populations in a southeastern United States hardwood forest; and relationships between body size, size of fat bodies, and total lipid content in the canebrake rattlesnake (Crotalus horridus) and the black racer (Coluber constrictor). (H.L.W.)

4719 (SRO-310-1(Pt.2)) SAVANNAH RIVER ECOLOGY LABORATORY. Annual Report, 1971. Beyers, Robert J.; Brisbin, I. L.; Coleman, D. C.; Gentry, J. B.; Gibbons, J. W.; Smith, M. H. (eds.) (Georgia Univ., Athens. Inst. of Ecology). Aug 1971. Contract AT(38-1)-310. 196p. Dep. NTIS.

Progress is reported on the following research projects: concentrations of boron in surface waters, rainfall, and aquatic plants; production and chemical composition of an aquatic herb, Saururus cernuus, at different sites; response to predation by colonies of the southern harvester ant, Pogonomyrmex badius; relationships between primary productivity and mosquitofish (Gambusia affinis) production in large microcosms; determination of anuran terrestrial activity patterns by a drift fence method; seasonal variations in the live weights and major body components of captive box turtles; determining density for small mammal populations using a grid and assessment lines; and effects of immigrants on the spatial structure of a small mammal community. (H.L.W.)

4720 (SRO-642-1) EVALUATION OF THE FACTORS INVOLVED IN BIOACCUMULATION OF GAMMA-EMITTING RADIONUCLIDES IN WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS). Third Technical Progress Report, February 1, 1971–January 31, 1972. Jenkins, J. H. (Georgia Univ., Athens. School of Forest Resources). 1 Nov 1971. Contract AT(38-1)-642. 38p. Dep. NTIS.

Muscle samples from 267 white-tailed deer were analyzed for gamma emitting radionuclides for the period of October 70 to September 71. The only gamma emitter detected of public health concern was ^{137}Cs. As previously reported the Lower Coastal Plain yielded samples significantly higher than the other physiographic regions of the Southeast with late fall and winter months being the peak season. Lower Coastal Plain deer last winter in Georgia averaged about 27,000 pCi/Kg in radio-cesium with one sample reaching a high of over 100,000 pCi/Kg. Specimens from the Upper Coastal Plain and the Piedmont averaged 5,842 pCi/Kg and 726 pCi/Kg. These values are slightly lower than in the previous year; however, individual counts ranged much higher indicating a unique transport system of ^{137}Cs from soil and vegetation into wildlife species. Strontium-90 data closely parallels that of ^{137}Cs in relation to areas of high bioaccumulation. Potassium deficiency has been considered to be of prime importance in bioaccumulation studies. To better understand the mechanism involved in plant uptake of radiocesium, a controlled study is in progress to determine the effects of fertilization of radionuclide absorption by plants. This project involves a comparison of ^{137}Cs content in vegetation from both fertilized and unfertilized plots of land in the Waycross area. Preliminary data show seasonal variation in ^{137}Cs content. Values ranging from 1,711 pCi/Kg of ^{137}Cs to 52,435 pCi/Kg have been obtained for dried and ground bay leaves, a food plant commonly eaten by deer in that area. The biological half life of ^{137}Cs in two bobcats was determined by us as forty to fifty days last year. These same animals were then used to determine the concentration factor of ^{137}Cs from primary food source (reactor contaminated fish) to consumer (the wildcats). Under natural conditions considerable supporting data indicates a 2.5 concentration factor for this species. Presently the captive animals show a twofold increase in ^{137}Cs and are still increasing. Soil and vegetation samples from the Lower Coastal Plain are most deficient in potassium. Potassium concentration of vegetation was 4.5 times higher in the Piedmont than in the Lower Coastal Plain and fertilized deer food patch vegetation contained 20× more than nearby natural vegetation. Mean ^{137}Cs concentrations in Lower Coastal Plain vegetation was 2 to 10 times higher than Piedmont vegetation. Upper Coastal Plain, Piedmont, and Mountain soils had cation exchange capacities, ^{137}Cs fixing capacities, and exchangeable potassium several times greater than the Lower Coastal Plain soils. Somewhat surprisingly in view of the high bioaccumulation of ^{137}Cs in deer in the Lower Coastal Plain, the ^{137}Cs concentration in the soils was less in the Lower Coastal Plain than in the Upper Coastal Plain and Piedmont. Soil pH was about the same in all physiographic regions. For the past 16 years an annual furbearer census was conducted at the Savannah River Plant, South Carolina. Animals captured on this census provide a yearly background index for radiation in various forms of wildlife. Muscle and bone samples from specimens are submitted to the Health Physics laboratory for radiation detection. This provides a check on radiation monitoring equipment and methods. Furbearers showed some decline this past year and this correlates with small mammal population data and other trapping and observational data from the area. Although it is still too early to set up complete models of fallout bioaccumulation in the Southeast several conclusions are valid: the amount of ^{137}Cs in the soil is usually unrelated to the amount of uptake in plants; high uptake in plants is usually related to high bioaccumulation of ^{137}Cs and ^{90}Sr in mammals; bioaccumulation is more dramatic under conditions of severe potassium deficiency; sterile, sandy soils are essential for biomagnification; high biomagnification would appear at this time to be confined to the Lower Coastal Plain and the Arctic; and high water tables are usually involved along with some specific radionuclide concentrating plants. (auth)

4721 (TID-3910(Suppl.7)) TERRESTRIAL AND FRESHWATER RADIOECOLOGY. A Selected Bibliography. Klement, Alfred W. Jr. (Division of Radiation Protection Standards (AEC), Washington, D. C.); Schultz, Vincent (Washington State Univ., Pullman. Dept. of Zoology). Oct 1971. Contract AT(45-1)-2221. 219p. Dep. NTIS.

A list of 2443 references to recent publications in the world literature related to the radioecology of freshwater and terrestrial ecosystems is presented. The list also includes references to tracer studies on pesticides and reports concerning organisms at nuclear energy installations even though the particular study did not involve research on radiation effects or cycling of radionuclides. A separate list of 36 bibliographies is also included. (E.R.B.)

4722 (UCRL-73168) RADIOECOLOGICAL STUDY OF THE HUMBOLDT BAY MARINE ENVIRONMENT. Heft, Robert E.; Harrison, Florence L.; Phillips, William A. (California Univ., Livermore. Lawrence Radiation Lab.). 31 Aug 1971. 15p. (CONF-710818-3). Dep. NTIS.

From Meeting on nuclear methods in environmental research; Columbia, Mo. (23 Aug 1971).

Operation of the Pacific Gas and Electric Co. power reactor at Humboldt Bay, Eureka, California, produces as a by-product in low concentration in aqueous solution a number of radionuclides (fission products, ^{65}Zn, ^{60}Co, ^{54}Mn, ^{3}H, etc.). At irregular intervals the accumulated radioactive liquid waste is released into the bay in accordance with limits prescribed by the Atomic Energy Commission and the State of California North Coastal Regional Water Control Board. At any given location in the Humboldt Bay marine environment, the concentration of each of the radionuclides increases to some low level following a release from the waste treatment system and then decreases monotonically until the next release. The individual radionuclides may be expected to exhibit different variations of concentration with time depending on the rates of their reactions with bottom sediments, suspended sediments, and various marine organisms. The Bio-Medical Division of Lawrence Livermore Laboratory, Livermore, in cooperation with PG&E personnel at the Humboldt Bay Power Plant and at the Department of Engineering Research, has undertaken a program to study the marine radioecological system at Humboldt Bay. (auth)

4723 RADIOACTIVE CONTAMINATION AND BIOLOGICAL PERIOD. Avio, C. M. Ann. Med. Nav.; 75: 193-242(May-Jun 1970). (In Italian).

The fundamental aspects of radiocontamination are reviewed with special consideration to mechanism of production, cycles of the radioisotopes in the biosphere, ways of penetration, and ecological chains. The researches carried out on this subject at the Laboratory of Radiopathology of Camen are described. They consist mainly in the collection of a very extensive bibliography on contamination by ^{90}Sr and ^{239}Pu and in experimental studies on the biological period and fixation of radioisotopes by unicellular organisms (marine algae). (80 references) (auth)

4724 RADIOECOLOGICAL STUDIES IN SOIL ZOOLOGY. Gilyarov, M. S.; Krivolutskii, D. A. Zool. Zh.; 50: No. 3, 329-42(1971). (In Russian).

Arthropod populations were used as bioindicators for ^{90}Sr environmental contamination of forests. Contamination by 1.8 to 3.4 mCi/m^2 ^{90}Sr of a 1-ha birch forest reduced the population of the saprophytes 70-fold, due to their low mobility and topsoil habitat, of phytophytes by one half, and of predators by one third. Insects with high mobility were unsuitable as bioindicators. The number of microarthropods did not diminish but the number of species declined 4-fold. (TSS)

4725 NATURAL RADIOACTIVITY LEVELS IN INDIAN SOILS. Mishra, U. C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay). J. Sci. Ind. Res.; 30: No. 2, 59-62(Feb 1971).

The results of gamma spectrometric estimation of the concentrations of ^{232}Th, ^{238}U, and their decay products, and ^{40}K in soil samples collected from different places in India are presented. A brief description of the sampling and counting methods employed is given. The advantages and limitations of the gamma spectrometric methods of soil measurements are mentioned. The regional distribution of these elements is discussed and the areas requiring detailed studies are suggested. The external gamma radiation doses due to these elements were computed and compared with the global averages. (auth)

4726 ^{137}Cs FROM ENVIRONMENTAL SOURCES IN DESERT RANGE CATTLE FROM 1962 THROUGH 1968. Blincoe, Clifton; Bohman, V. R. (Univ. of Nevada, Reno). Environ. Res.; 4: No. 3, 193-200(Aug 1971).

Following the cessation of atmospheric nuclear weapons testing in late 1962, cesium-137 concentrations in desert range cattle continued to increase for a year and then decreased following the trend in worldwide fallout. On the Nevada Test Site of the U. S. Atomic Energy Commission, range cattle soft-tissue concentrations of ^{137}Cs reached a maximum earlier, indicating response to local contamination. Tissue ^{137}Cs concentrations did not respond to small, isolated releases of fission products from underground testing. The levels of ^{137}Cs observed were comparable with those found in meat elsewhere in the northern hemisphere. (auth)

4727 UPTAKE OF ^{58}Co BY MUSSEL, MYTILUS EDULIS. Shimizu, Makoto (Tokyo Univ.); Kajihara, Takeshi; Suyama, Ippei; Hiyama, Yoshio. J. Radiat. Res.; 12: No. 1, 17-28 (Mar 1971).

Uptake of radioactive cobalt (^{58}Co) by shellfish was determined by tracer experiments using mussel, Mytilus edulis, which has a world-wide distribution and is considered to be a sufficiently reliable indicator organism of radioactive contamination of the marine environment. As for soft tissues accumulation was high in the alimentary tract, and low in the mantle and the adductor muscle. However high concentration factors in the byssus (1,500) and shell (190) were noticeable. By means of immersion experiments of shell pieces and cut off pieces of the byssus in ^{58}Co containing sea water, it became evident that the high accumulation of ^{58}Co by the byssus and shell was due to surface adsorption. Discussions are given on the utility of mussel as an indicator organism and on the role of structural protein of shellfish in the adsorption of radionuclides. (auth)

Genetics and Cytogenetics

Refer also to abstracts 4684, 4685, 4706, 4864, 4867, and 4880.

4728 (ORNL-TM-3603) TESTING FOR THE MUTAGENICITY OF IRRADIATED STRAWBERRIES FED TO RATS IN A HOST-MEDIATED ASSAY WITH NEUROSPORA AS INDICATOR ORGANISM. Malling, H. V.; de Serres, F. J.; Mitchell, T. (Oak Ridge National Lab., Tenn.); Nees, P. (Wisconsin Alumni Research Foundation, Madison). Oct 1971. Contract W-7405-eng-26. 29p. Dep. NTIS.

Mutagenic effects of irradiated strawberries on Neurospora crassa were studied by injecting conidia into the peritoneal cavity of rats fed the irradiated fruit. The experiments consisted of several groups of rats fed normal food, and frozen and dried strawberries gamma-irradiated with various doses. Controls consisted of rats treated with methyl methanesulfonate (MMS) by force-feeding. It was found that mutations were induced in Neurospora conidia incubated in the peritoneal cavity of MMS-treated rats. Mutations were also induced in conidia treated in vitro with MMS. Neurospora from rats fed irradiated strawberries showed no higher frequency of mutations than Neurospora from rats fed a normal diet. (H.L.W.)

4729 (ORO-2832-93) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, October 16, 1970-October 15, 1971. Shalek, Robert J. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Contract AT(40-1)-2832. 23p. Dep. NTIS.

Studies on chromosome organization included the following research projects: improvement of electron optical methods; analysis of cellular ion distributions by soft x-ray fluorescence; improvement of chromosome isolation techniques; development of techniques for electron microscopic examination of specific ultracentrifuge sedimentation fractions of chromosomal material; and analysis of DNA from chromosomes of various sizes. Studies on nucleoprotein organization included reconstitution experiments for determining whether or not there was a significant difference between products formed by salt gradient dialysis and those resulting from the slow direct method of reconstitution, analysis of thermal denaturation of nucleoproteins, and use of an automatic multiple-wavelength scanner for thermal denaturation analysis of DNA and nucleohistones. Progress is also reported on particle beam irradiation studies of DNA strand scission and chromosomal damage and gamma ray and neutron irradiation studies of nucleohistone damage. (H.L.W.)

4730 (ORO-4024-2) EFFECT OF RADIATION-SENSITIVE MUTATIONS AND RADIATION ON RECOMBINATION IN PARTIALLY DIPLOID DERIVATIVES OF ESCHERICHIA COLI. Progress Report. [Texas Univ., Houston. Graduate School of Biomedical Sciences]. 26 Oct 1971. Contract AT(40-1)-4024. 9p. Dep. NTIS.

Polarity in recombinational events involving the F-merogenotic system was studied using the histidine, threonine, arabinose, and leucine operons. It was concluded that the recombinational event is not confined to an operon but usually involves a much larger segment of the chromosome. Studies were initiated on transition mutations for obtaining reciprocity data. Ultraviolet-sensitive mutations of Howard-Flanders, which effect the excision enzyme of the dark repair system, were introduced into partially diploid strains that carry highly stable mutations that do not appear in recombinant products. Results of investigations are tabulated. (H.L.W.)

4731 STUDIES ON THE LYMPHOCYTES OF PATIENTS WITH RENAL HOMOGRAFTS. Kingston, Anne; Harnden, D. G.; Woodruff, M. F. A.; Nolan, B.; Robson, J. S. (Univ. of Birmingham, Eng. Univ. of Edinburgh. Royal Infirmary, Edinburgh). Transplantation; 12: No. 4, 305-9(Oct 1971).

Several reports of an increased incidence of malignant disease in renal homograft patients, who were under immunosuppression, led us to consider the possibility of chromosome damage to the lymphocytes in such patients. Peripheral blood samples from 19 renal homograft recipients and 19 patients being treated by haemodialysis were studied. Chromosome damage in excess of normal levels was observed in the lymphocytes of both groups. The damage in the homograft patients could be attributed almost exclusively to radiation therapy. There was no evidence of increased chromosome damage in immunosuppressed patients who were not irradiated. No obvious explanation could be found for the elevated levels of chromosome damage in the dialysis patients. The response of the lymphocytes to phytohaemagglutinin (PHA) was depressed in the homograft patients. (auth)

4732 LONG TERM EXPOSURE OF SEVERAL PERSONS FROM LOST RADIOFORES IN A MEDICAL ESTABLISHMENT. Klener, V.; Tuscany, R.; Kudrna, J. (Institut Hygieny a Epidemiologie, Prague). Prac. Lek.; 23: No. 7, 237-40(Sep 1971). (In Czech).

Analysis is presented of the uncontrolled exposure of four female workers at a medical establishment where approximately 30 years ago, probably in building constructions, seven application needles containing a total of approximately 15 mg ^{226}Ra were built into the floor. Because the working schedule in recent years was known and the dose rates were measured, it was possible to estimate the yearly exposure (1.5 to 12 R). No clinical or hematologic deviations were ascertained in the exposed women. Karyologic examination of the peripheral lymphocytes disclosed during one year after interrupting the exposure, repeated incidence of cells with unstable aberrations. At the present level of findings, this can not be considered to be a manifestation of prodrome of illness. (auth)

4733 PATHOGENICITY OF SOME GAMMA-INDUCED FUSARIUM MONILIFORME MUTANTS. Ali, A. M. M.; Younis, S. E. A. (National Research Centre, Cairo. Atomic Energy Establishment, Cairo). Isotope Radiat. Res.; 4: 107-13(Jun 1971).

Any new host variety that proved to be resistant to a particular pathogen in certain time might loose this character by the developing of new strains. The purpose of the present investigation is an attempt to determine the pathogenicity of fourteen Fusarium moniliforme mutants obtained by Younis and Ali (1969) following γ irradiation, one mutant from each of the doses; 1, 5, 10, 100, and 120 kR and nine mutants from the dose 80 kR. The results showed that the four Egyptian corn varieties were susceptible with insignificant differences among them in their susceptibility to corn stalk rot pathogen strains. F. moniliforme strains, under investigation, differed significantly in their pathogenicity to corn varieties. Significant interactions between F. moniliforme strains and corn varieties were also obtained. The biochemical mutant did not show any sig-

nificant difference in its pathogenicity from any of the other strains including the wild-type. Significant difference in the pathogenicity of the mutants could be obtained between the fuzzy strain and any of those that were purple or whitish on YEP. The breeding programs for disease resistance need different strains of the pathogen to test host resistance. The host variety that proves to be resistant to a wider variation of the pathogen will persist resistant for a longer time than others overcoming the new pathogenic mutants occurring in nature. (auth)

4734 INHERITANCE OF SPONTANEOUS MUTABILITY IN YEAST. von Borstel, R. C.; Cain, Katherine T.; Steinberg, C. M. (Oak Ridge National Lab., Tenn. Inst. of Immunology, Basel). Genetics; 69: No. 1, 17-27(Sep 1971).

Spontaneous mutation rates were measured in several radiation-sensitive and wild-type strains of yeast. The method used for measuring the rates is by a 1000-compartment fluctuation test where growth is eventually stopped by limitation of one of the genetically controlled requirements; revertant colonies form in liquid medium in the bottom of each compartment. The kinetics of mutant appearance was determined; it was seen that after their appearing over a three- or four-day interval, mutants appear only infrequently in older cultures. It was found that three out of seven radiation-sensitive alleles at five loci are associated with enhanced mutation rates. Two of these radiation-sensitive mutants (uxs1-1 and xrs3-1) confer enhanced mutation rates in Class I super-suppressors but not at the suppressible (nonsense) locus; the other radiation-sensitive mutant (xrs1-1) enhances the rate of mutation at both the nonsense locus and the suppressors, but much more in the latter. The radiation-sensitive mutant uvs9-2 depresses the mutation rate for the suppressors. The mutators associated with uxs1-1 and xrs1-1 are both recessive. Also these two mutators enhance mutation rates for the frameshift mutant ura4-11. We argue that the mutators act by affecting the addition or deletion of bases in DNA. Two separately derived cytoplasmic petites [rho$^-$] are base-substitution mutators. (auth)

4735 ISOLATION AND GENETIC CHARACTERIZATION OF RECOMBINATION DEFICIENT MUTANTS IN SACCHAROMYCES CEREVISIAE. Rodarte-Ramon, Ubaldo Sergio. Berkeley, Calif.; Univ. of California (1970). 83p. University Microfilms Order No. 71-20,901.

Thesis.

Recombination in Saccharomyces cerevisiae has been studied genetically by selecting mutants of disomic yeast deficient in x-ray and ultraviolet light (UV) induced mitotic heteroallelic reversion. Disomics were obtained by isolation techniques based on detection of heteroallelic regions in one chromosome. They were also recovered spontaneously. Of ten identified rec mutants, seven were studied in detail. The mutants exhibit depressed frequencies of x-ray and/or uv-induced reversion in the heteroallelic region arg4-2 +/+ arg4-17 on disomic chromosome VIII. Two of the mutants are x-ray sensitive and one is both x-ray and uv-sensitive. The remaining four strains exhibit wild type response to both radiations. Each of the seven mutations segregates as one gene and is recessive. Complementation and allelism tests were performed and a minimum of four genes, denoted rec1, rec2, rec3, rec4, were identified among the seven mutants. Mutations in rec1 depress x-ray and uv-induced mitotic conversion about 20 times and do not affect either x-ray induced mitotic segregation of ade2 or meiotic intragenic or intergenic recombination. Mutations in rec2 cause x-ray sensitivity and depress x-ray induced conversion to about 20% of the normal value, but do not affect UV induction of reversion. Homozygous rec2/rec2 diploids yield only 1 to 2 percent sporulation and 10 percent spore viability. They also exhibit normal frequencies of x-ray induced mitotic crossing over of ade2. Mutations in rec3 completely suppress spontaneous and x-ray or uv-induced mitotic conversion and also suppress sporulation. X-ray induced mitotic segregation of cyh2 occurs at normal frequencies By analogy with results in E. coli it is suggested that induced lesions in DNA stimulate recombination, while rec mutants are unable to complete the steps required for exchange. Wild type sensitivity to radiation induced damage in some mutants suggests that recombination in yeast may also proceed in pathways not involving repair of radiation damage. Common processes for mitosis and meiosis are suggested by the existence of mutants rec2, rec3, and rec4. Mutations in rec4 suggest common steps leading to single site conversion in mitosis and meiosis. The low sporulation and low spore viability associated with the rec2 mutations are suggested to be an indication of impairment in the mechanism for chromosomal disjunction. (Diss. Abstr.)

4736 INDUCED MUTATIONS IN A SWEET CAPSULARIS JUTE. Majumdar, T. K.; Bhaduri, P. N. (Burdwan Univ., West Bengal, India). Curr. Sci. (India); 40: No. 21, 582-3 (5 Nov 1971).

X radiation doses of 10 to 90 kR were administered to dry and wet seeds of the Tripura variety of Corchorus capsularis and mutations of leaves, stems, and flowers were isolated. One mutant showing improved fiber quality was selected for breeding and production of a superior variety of C. capsularis. Tables are presented to show mutation frequencies in the F_2 progenies of irradiated seeds and physical measurements of four classes of the F_3 progenies. (H.L.W.)

Health Physics and Safety

Refer also to abstracts 4416 and 4427.

Radioactive Contamination and Decontamination

Refer also to abstracts 4266, 4444, 4677, 4704, 4707, 4711, 4713–4716, 4720, 4722–4724, 4727, and 4866.

4737 (AWTSC-2) ^{90}Sr AND ^{137}Cs IN THE AUSTRALIAN ENVIRONMENT DURING 1969 AND SOME RESULTS FOR 1970. (Atomic Weapons Tests Safety Committee, Victoria (Australia)). May 1971. 42p. Dep. NTIS (U. S. Sales Only).

Measurements are reported on ^{90}Sr and ^{137}Cs in Australia for 1969 and 1970. These long-lived radioisotopes from nuclear weapons tests were monitored in fallout deposition from the atmosphere, in key foodstuffs, and in representative members of the population. Any effect of ^{90}Sr on individuals in the population results from the radiation doses it delivers to bone tissue, after ingestion in foodstuffs. During 1969 these radiation doses to Australians corresponded to less than 2% of the average annual background radiation from natural sources. The most important effect of ^{137}Cs is of consequence to the whole population rather than to the individual as it results from irradiation of the reproductive cells, potentially affecting the hereditary material. During 1970, the radiation doses to Australians due to ^{137}Cs both in their bodies and in the environment, corresponded to less than 1% of the average annual background radiation from natural sources. (auth) (Australia)

4738 (BNWL-B-136) ROUTINE ENVIRONMENTAL SURVEILLANCE PROGRAM: MASTER SCHEDULE, FY 1971. Effective September 1, 1971. Corley, J. P. (Battelle Pacific Northwest Labs., Richland, Wash.). Sep 1971. Contract AT(45-1)-1830. 28p. Dep. NTIS.

The current schedule of data collection for the routine environmental surveillance program at the Hanford plant conducted by Environmental Evaluations for the Atomic Energy Commission is presented. Much of the data collected is available in routine reports issued by the Environmental Evaluations staff. Data from sampling locations within the plant boundaries are presented in the annual Environmental Status of the Hanford Reservation report series. Data from off-plant locations are presented in the annual Evaluation of Radiological Conditions in the Vicinity of Hanford series of reports. Shutdown of the K reactors, leaving N as the only operating production reactor, permitted a major de-emphasis of the river-associated portions of the routine surveillance program. Although some effort continues in all media categories, specific measurement for short-lived nuclides is no longer required, and the time-scale of any remaining sources of activity release to the river is such as to permit reduced measurement frequency. A number of changes were made in the groundwater for ^3H and NO_3 ion near the reactor areas. Changes in the air sample program have been primarily in the composite groupings for specific radionuclide analyses. Soil, vegetation, and small mammal sampling were placed on a routine schedule, in part to respond to requests for data on plutonium in the local environment and in part to initiate better baseline measurements within the reservation prior to construction and operation of new facilities. (C.H.)

4739 (CONF-711113-1) BIOLOGICAL TREATMENT OF LIQUID WASTES AND DISCHARGE TO SANITARY SEWERS. Slansky, Cyril M. (Allied Chemical Corp., Idaho Falls, Idaho). 8 Oct 1971. 10p. Dep. NTIS.

From Regional training course in radioactive waste management conference; Tokyo, Japan (4 Nov 1971).

Methods for the biological treatment of liquid wastes containing radioisotopes are reviewed. The effectiveness of Imhoff type septic tanks, primary sedimentation tanks, trickling filters, activated sludge, and oxidation ponds for the removal of radioisotopes from liquid wastes is evaluated. The effects of radiation doses found in the wastes on the survival of bacteria are considered. A

guide for maximum permissible discharge of radioactive wastes into sanitary sewage systems is included. (C.H.)

4740 (NIRS-RSD-30) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). Feb 1971. 23p. Dep. NTIS (U. S. Sales Only).

Data are presented on the content of ^{137}Cs and ^{90}Sr in samples of rain water, atmosphere, milk, and the total diet in Japan during April 1970 through March 1971. Data are included on the content of ^{90}Sr in human bone samples collected during the time period and on the content of ^{137}Cs in adult males measured using whole-body counting. (C.H.)

4741 (ORNL-TM-3135) PRELIMINARY SYSTEMS ANALYSIS MODEL OF RADIOACTIVITY TRANSFER TO MAN FROM DEPOSITION IN A TERRESTRIAL ENVIRONMENT. Booth, R. S.; Kaye, Steven V. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 21p. Dep. NTIS.

A mathematical model was constructed simulating selected terrestrial pathways by which fallout radioactivity can be transferred ultimately to man. This model is intended for preliminary predictions of radionuclide intakes by man through consumption of milk, beef, and plant parts contaminated directly by fallout as well as by uptake from the soil. The intake rates and total intakes of 25 radionuclides were predicted for a standard man based on a hypothetical fallout of 1 $\mu Ci/m^2$ of each radionuclide. In the first few days after deposition, milk and directly contaminated plant parts provided the greatest intake of radioactivity from this mixture of radionuclides. After about 30 days, the intake rate via beef was 2.5 times more important than that from directly contaminated plant parts. By 500 days, the intake rate from plant parts contaminated by uptake from the soil was the most important source of radioactivity to man in the contaminated area. This generalized dynamic model is sufficiently versatile that it can be applied to many terrestrial environments and to all radionuclides. (auth)

4742 (PNE-G-78) DESERT VEGETATION UPTAKE OF TRITIUM FROM PROJECT GASBUGGY EFFLUENT. Mason, B. J.; Brown, K. W.; Hop, H. W.; Miller, C. L. (Western Environmental Research Lab., Las Vegas, Nev.). [nd]. 15p. Dep. NTIS.

Project Gasbuggy, a test in the U. S. Atomic Energy Commission's Plowshare Program, was conducted to evaluate the feasibility of using nuclear explosives to improve the yield of natural gas from tight geological formations. This test was conducted on December 10, 1967, at a site east of Farmington, New Mexico, on the Carson National Forest. Following the detonation and redrilling operation, the well was flow-tested on several occasions by burning or flaring the natural gas taken from the cavity created by the device explosion. One period of flaring was for 15 days during the period June 13 to July 20, 1968. A second period of flaring began on November 4, 1968, and continued at varying rates through early October 1969. As part of a program of environmental sampling, vegetation samples from trees, shrubs, grasses, and annuals were collected at a number of close-in stations located within three miles of the site. The samples were analyzed for tritium, the primary radioactive component of the gas. Evaluation of the data derived from this study indicated that there appeared to be an increasing trend leading away from the stack where the gas was flared. Predictions using Pasquill's equation suggest that such an increase should occur. Results showed that the units used to measure tritium activity in vegetation can have an influence on the interpretation of the results. If true background levels are being investigated, specific activity offers the most meaningful number because it reflects the natural levels in the environment. However, if a contaminating event is being investigated, units which express the activity on a dry-weight basis provide a means for overcoming the problems of varying moisture contents which can occur over large areas. It is recommended that both units be investigated along with the moisture data before conclusions are drawn from the data. Pasquill's equation appears to offer a reasonable means of predicting the location of the maximum airborne concentrations of tritium in rugged areas similar to those around the Gasbuggy site. The effect of terrain features upon air movement can be deduced from the vegetation data in limited areas such as was shown for the influence of stream channel alignment. (C.H.)

4743 (RISO-245) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1970. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1971. 95p. Dep. NTIS (U. S. Sales Only).

Measurements of fall-out radioactivity in Denmark in 1970 are reported. Strontium-90 was determined in samples from all over the country of precipitation, soil, ground water, surface water, seawater, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Furthermore ^{90}Sr was determined in local samples of air, rain water, grass, sea plants, fish, and meat. Cesium-137 was determined in soil, milk, grain products, potatoes, vegetables, fruit, total diet, and meat, and ^{137}Cs was measured by whole-body counting in persons from a control group at Risö. Estimates of the mean contents of radiostrontium and radiocesium in the human diet in Denmark in 1970 are given. The γ background activity was measured regularly at locations around Risö, at ten of the State experimental farms, and in an area in Zealand, one in Jutland where future nuclear power plants might be located, and along the shores of the Great Belt. Finally the report includes, as previously, regular surveys of environmental samples from the Risö area. (auth) (Denmark)

4744 (UCRL-72926) GAMMA-EMITTING RADIONUCLIDES IN ALASKAN ENVIRONMENTS 1967-1970. Koranda, John J.; Martin, John R. (California Univ., Livermore. Lawrence Radiation Lab.). 5 May 1971. 65p. (CONF-710501-41). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Results are presented of radiological analyses of plant and soil samples collected during the summers of 1967, 1968, and 1970 during periods of pre- and post-operational test activities at the supplemental underground nuclear explosion test site on Amchitka Island, Alaska. In addition to the samples collected on Amchitka Island, collections were also made in coastal Alaska (in the Anchorage-Palmer, Portage area) and central Alaska (in the Fairbanks-College area). Attempts were made to collect the same species of plant or a related species in the same genus at all three locations. The collections from coastal and interior Alaska were made to relate the levels of environmental radioactivity on Amchitka Island to those of the boreal and arctic regions, which have been recognized as being high for certain radionuclides. Environmental radioactivity, except for natural radioactivity, is for the most part the result of radioisotopes produced in past nuclear weapons tests and deposited (mainly in the northern hemisphere) as atmospheric fallout. (C.H.)

4745 (UCRL-73089) RADIOECOLOGICAL STUDIES IN UTAH SUBSEQUENT TO THE BANEBERRY EVENT. Pendleton, R. C. (Utah Univ., Salt Lake City); Koranda, J. J. (California Univ., Livermore. Lawrence Radiation Lab.); Wagner, W. W. (Utah Univ., Salt Lake City); Phelps, P. L. (California Univ., Livermore. Lawrence Radiation Lab.); Lloyd, R. D. (Utah Univ., Salt Lake City); Anspaugh, L. R.; Chapman, W. H. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Sep 1971. 47p. (CONF-710501-44). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn.

The Baneberry Event was an underground weapons test conducted at the Nevada Test Site on the morning of 18 December 1970. Accidental venting occurred, producing a cloud of radioactivity that moved over central and northern Nevada into Utah. Data from the gross β radiation monitors indicated that cloud arrival time in Salt Lake City was approximately 08 to 0900 on 19 December 1970. This was substantiated by the meteorological data. The counting rates recorded indicated that radioactivity in the air continued to rise during the night of 19 December and into the 20th of December. Filter data obtained with the SAS samplers indicated cloud passage or departure late on 20 December. Specimens of wild and domestic mammals, vegetation, milk, and snow were collected for analyses of radioactivity from 20 December 1970 into January 1971. Radioactive aerosols were detected in Utah at 0800 to 0900 December 19, 1970, and moved out of the sampling pattern after two to four days. Concentrations of radioactivity in air were the highest in the north and northwest part of the state with the maximum in the Salt Lake Valley. Radioisotopes of iodine (^{131}I and ^{133}I) made up the major portion of the activity. Radiation doses to humans, including infants, from all significant radionuclides known or calculated to have been released in the Baneberry venting were estimated. In each case, the largest potential dose was to the thyroid. The estimated dose received from inhalation and submersion was 0.005 rem to the thyroid. The sum of the integrated air activities for all nuclides measured or estimated at Salt Lake City was one percent of the allowable integrated air activities over a one-year period. The total dose to a child's thyroid resulting from the cow-milk pathway was calculated to be approximately 0.012 rem. Winter conditions and typical winter feeding practices for grazing animals in Utah at the time of the Baneberry venting prevented significant human exposures. Based on air concentrations determined during the Baneberry cloud passage, the radiation dose to the 0 to 2 year old child that could have occurred if the accidental venting had taken place in the summer when dairy animals were eating fresh forage was calculated

to be 1.3 rem for the dry deposition condition, and approximately 100 rem for rainout deposition. (C.H.)

4746 (UCRL-73429) ENVIRONMENTAL ASPECTS OF NATURAL GAS STIMULATION EXPERIMENTS WITH NUCLEAR DEVICES. Anspaugh, L. R.; Koranda, J. J.; Robison, W. L. (California Univ., Livermore. Lawrence Radiation Lab.). 27 Aug 1971. 47p. (PNE-R-53; CONF-710501-39). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

It is likely that future activities administered by the USAEC Division of Peaceful Nuclear Explosives will be in the area of underground engineering, and particularly in the stimulation of deeply buried natural gas reservoirs of low permeability. The successful development of this technology could double the proved recoverable resources of natural gas in the United States. During the developmental stage of the technology, large quantities of THO are released to the environment as the gas is withdrawn. Efforts to predict potential doses resulting from such releases have been severely handicapped by the lack of adequate data to predict the ecological movement of THO. A radioecological study was conducted in conjunction with Project Rulison, the second nuclear-stimulation experiment, to evaluate these parameters; controlled laboratory studies were also initiated. The results indicate that the environmental residence time of THO is at least an order of magnitude shorter than has been frequently assumed, and that this invalidates the commonly used deposition velocity approach for the calculation of doses due to food chain contamination by THO vapor. (58 references) (auth)

4747 SOME PROBLEMS OF THE INTERACTION OF HARMFUL AGENTS IN THE OPEN ATMOSPHERE. Strecha, M. (Koninski Univ., Bratislava). Bratislav. Lek. Listy; 55: 126-32(1971). (In Slovak).

Analysis of noxious agents in the atmosphere over cities raises many complex problems. The various harmful agents present in the air may interact with each other, yielding new, potentially toxic products. Public health experts must consider the combined effects of these agents. The materials enter the atmosphere as the result of natural processes, biological functions of living matter, and as the result of human activity. At present, the atmosphere is greatly contaminated. It contains aerosols of metallic elements, among which Si, Ca, Al, Fe, Mg, Pb, Cu, Zn are most abundant. Other contaminants include SO_2, SO_3, H_2SO_4, CS_2, H_2S, mercaptans, thioethers, sulfoxides, etc. Ozone is formed by photochemical reactions; CO is released primarily through the exhaust of motor vehicles. Radioactive materials represent another important group of noxious agents. Their presence is due to the increased background resulting from the growth of industrial activity, nuclear power generation, use of isotopes in research, medicine and agriculture, and the earlier atomic tests in the atmosphere. From the viewpoint of atmospheric contamination, ^{32}P, ^{131}I, ^{60}Co, ^{90}Sr, ^{14}C, ^{35}S, ^{45}Ca, ^{226}Ra and U are most important. They may be present in the air as compounds or in the elementary form. The potential interactions of these materials are summarized. (14 references). (TTT)

4748 PROBLEM OF DRINKING WATER IN RURAL REGIONS IN CASE OF HEAVY FALLOUT. Bourrier, M. Compt. Rend. Hebd. Seances Acad. Agr. Fr.; 54: 1004-15(1968). (In French).

The problem of providing drinking water for rural populations during periods of heavy fallout following nuclear attack presents some special difficulties such as lack of communication between civil authorities and the rural population, lack of knowledge of ways to decontaminate water, and lack of means of determining contamination levels of water. These can be easily solved by the use of deep wells and by preliminary training of rural inhabitants in methods of decontamination. (J.S.R.)

4749 SOME NOTES ON A RADIUM CONTAMINATION. Makedanz, A.; Rehak, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radiobiol.-Radiother.; 12: No. 2, 257-63 (1971). (In German).

A radium contamination is reported that had its origin in the breakage of a 10 mg radium needle. Necessary measures of radioprotection and decontamination are described and conclusions are drawn. (auth)

Dosimetry and Monitoring

Refer also to abstracts 4445, 4603, 4706, 4712, and 5592.

4750 (AECL-4052, pp 37-55) HEALTH PHYSICS BRANCH. Cowper, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 1971.

In Biology and Health Physics Division progress report.

Progress is reported on: neutron spectra in criticality accidents; intercomparison experiment on nuclear accident dosimetry systems; techniques of fission damage track measurements; the 05R Monte Carlo Code for neutron spectra calculations; neutron response of TLD-700 Chips; thermoluminescent dosimeters; semiconductor detectors; irradiation facility; energy loss in biomolecules; tritium-in-air monitoring; tritium-in-water monitoring; detection of iodine in air; microscopic flying spot scanner; pseudo-random pulse generating modules; radiation instrument developments; and routine dose monitoring. (H.L.W.)

4751 (BNWL-SA-3939) MODELING OF ENVIRONMENTAL PATHWAYS AND RADIATION DOSES FROM NUCLEAR FACILITIES. Soldat, J. K. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1971. Contract AT(45-1)-1830. 33p. (CONF-711008-4). Dep. NTIS.

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

Proper evaluation of radiation dose to people from nuclear facilities requires the summation of contributions from all facilities, nuclides, and exposure pathways of consequence. The relative importance of a particular pathway or source cannot always be judged without calculation of the incremental dose and the total dose. A computer model was developed that calculates total annual radiation doses and 50-year dose commitments to several categories of persons at population centers and combines these calculated doses into integrated (man-rem) annual and 50-year doses for large populations. The dose model was designed as one portion of an overall computer program developed to delineate the nuclear facilities expected in the year 2000, the radionuclides released to air and water, their diffusion, dispersion, and reconcentration in the environment, and the resulting radiation doses to people. Equations for calculating dose factors were derived from those given by the ICRP. Effective decay energies for various radionuclides were calculated from the ICRP model, which assumes that all the radionuclide is in the center of a spherical organ with an appropriate effective radius. Where data were lacking, metabolic parameters for the Standard Man were used for other ages as well. The model includes a sub-routine that calculates radionuclide concentrations in a wide variety of foods at time of harvest from concentrations in air, irrigation water, and soil. The later concentrations are output from previous portions of the overall computer program. The tremendous variety of data required for proper dose assessment was not always available in the literature. Such data must be extrapolated from environmental studies of fallout nuclides and from planned laboratory and field studies of a limited number of nuclides. (auth)

4752 (CEA-R-4224) MONITORING OF THE ENVIRONMENT AROUND A URANIUM ISOTOPE SEPARATION PLANT USING GASEOUS DIFFUSION. APPLICATION OF THE METHODS USED IN THE INVESTIGATION OF SUITABLE SITES FOR ADVANCED INDUSTRIES. Simeon, Claude (Commissariat a l'Energie Atomique, Pierrelatte (France)). Sep 1971. 20p. (In French). Dep. NTIS (U. S. Sales Only).

The guiding principles and structural organization, in the particular case of the Pierrelatte uranium isotope plant, are outlined, and the techniques used in industrial environmental monitoring are described. (France)

4753 (INMAS/HP-12-70) DOSIMETRY ON ^{169}Yb, ^{111}In, AND ^{113m}In LABELLED PHARMACEUTICALS. Sastry, K. G. K.; Reddy, A. R.; Nagaratnam, A. Institute of Nuclear Medicine and Allied Sciences, Delhi (India)). 1970. 10p. (CONF-701138-3). INIS.

From National symposium on radiation physics; Bombay, India (24 Nov 1970).

Radiation doses are estimated for ^{169}Yb, ^{111}In and ^{113m}In labeled-pharmaceuticals in different clinical situations. A chelating agent like DTPA labeled with any one of the above isotopes was used for kidney function test and brain scanning. The radiation doses per μCi injected were estimated. Doses with ^{169}Yb are observed to be higher than those with the other two isotopes in all organs. Indium-111 was superior to ^{169}Yb and in some cases to ^{113m}In from the radiation dose point of view. From the health physics and quality control point of view, ^{111}In was found to be better than ^{113m}In. Radiation doses in case of lung scanning and liver scanning with ^{113m}In labeled compounds were estimated for different age groups. In lung scanning, lung received a dose of 400 to 500 mrads when 1 μCi/gm of lung tissue was injected. In liver scanning, liver received a dose of 650 to 800 mrads when 1 μCi/gm of liver tissue was injected. (auth)

4754 (ORNL-TM-3601) QUARTERLY PROGRESS REPORT ON RADIOLOGICAL SAFETY OF PEACEFUL USES OF NUCLEAR EXPLOSIVES: HYPOTHETICAL EXPOSURES TO RULISON GAS. Barton, C. J.; Moore, R. E.; Hanna, S. R. (Oak Ridge National

Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 38p. Dep. NTIS.

Radiation doses that people living in a number of small Colorado communities would hypothetically receive from the use of Rulison natural gas were calculated. Two situations were considered involving introduction of one million cubic feet per day of dry, CO_2-free Rulison gas into the distribution system of either of the gas companies close to the Rulison well, the Rocky Mountain Natural Gas Company (RMNGC) and the Western Slope Gas Company – Rifle Division (WSGC). Production testing of the well has resulted in removal of most of the tritium that was initially present in the cavity but the maximum whole body dose from inhalation and skin absorption that might have been received if this gas had been used commercially by RMNGC instead of being flared (burned) is estimated to be 6 millirems/year from exposure to combustion products from an unvented stove and refrigerator. The maximum dose in the WSCG system, which affords little potential dilution of Rulison gas, is 39 millirems/year. This is about 23% of the Radiation Protection Guide of 170 millirems/year adopted by the former Federal Radiation Council. Inhalation and skin absorption of tritium dispersed in the atmosphere gave whole-body doses estimated to be less than 1 millirem/year. If the gas present in the well in August 1971 had been used under the same conditions, the maximum tritium whole-body dose would have been 0.03 millirem year. Whole-body doses from ^{85}Kr in Rulison gas were estimated to be about 1% of the tritium doses. (auth)

4755 (SZS–6/71) OCCUPATIONAL RADIATION EXPOSURE IN THE GERMAN DEMOCRATIC REPUBLIC IN 1969. Koenig, W.; Larssen, A.; Rothe, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Mar 1971. 24p. (In German). Dep. NTIS (U. S. Sales Only).

A total of 28,991 occupationally exposed persons were monitored by the central film badge service of the National Centre for Radiation Protection in the German Democratic Republic during 1969. Altogether 782 monthly over-exposures (more than 0.4 rad) were recorded. In 48 cases the quarterly dose (3 rad) was exceeded during one month. Only 22 of those records, however, could be assessed as real over-exposures. Most of the over-exposures occurred when safety regulations were insufficiently applied. The results were analyzed according to the type of institution, type and duration of employment, and age of the employee. (auth)

4756 (UCRL–73432) NATURAL RADIATION BACKGROUND DOSE MEASUREMENTS WITH CaF_2:Dy TLD. Jones, D. E.; Lindeken, C. L.; McMillen, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Sep 1971. 17p. (CONF-711026–1). Dep. NTIS.

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971).

Four quarterly and one monthly integrated environmental dose measurements were made with CaF_2: Dy TLD's in approximately 100 homes of Lawrence Livermore Laboratory employees and at selected out-of-doors locations. A nearly uniform geographic sampling was made of background dose in the 50 United States. These data represent simultaneous integrated measurements with uniform geometry. The quarterly data also represent the average seasonal dose rates for specific locations in the Livermore Area. At the median exposure (9.6 mR) from the quarterly home data, the individual values have a standard deviation of ±5%. Data are summarized and the technique and methods for overcoming phosphor limitations are discussed. This technique for natural background dose measurement was found to be reliable and relatively inexpensive. The major accuracy limitation was proper recognition and handling of potential nonrandom errors. These include factors such as fading and energy dependence. The phosphor response to cosmic radiation is under study as a potential source of error in TLD environmental measurements. (auth)

4757 (UJV-2696-D) REVIEW OF BIOLOGICAL BEHAVIOUR OF PERTECHNETATE-^{99m}Tc, IN SOME ORGANS AND CALCULATION OF RADIATION DOSES TO THESE ORGANS FROM ^{99m}Tc AND ITS POSSIBLE RADIONUCLIDIC IMPURITIES. Cifka, J.; Vesely, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sep 1971. 27p. Dep. NTIS (U. S. Sales Only).

The data concerning the tissue distribution of ^{99m}Tc, ^{99}Mo, and ^{131}I were critically reviewed and used for calculation of radiation doses to some human organs following interstitial administration. The cumulated radiation doses (in rads) to stomach (2.2); small intestine (0.5); upper large intestine (0.84); lower large intestine (1.0); kidneys (0.31); liver (0.24); thyroid (4.6); and total body (0.13) were calculated for 10 mCi of ^{99m}Tc administered intravenously. The cumulated radiation dose delivered to liver and total body from 10 μCi of ^{99}Mo (0.1 per cent of above mentioned activity of ^{99m}Tc was found to be 0.3 and 0.004 rads, respectively. The cumulated thyroid radiation dose from 20 μCi of ^{131}I (0.2 per cent of total ^{99m}Tc activity) was estimated to be 50 rads. These calculations show the necessity of further lowering of maximum permissible content of radionuclide impurities in eluates from ^{99m}Tc generators. (auth)

4758 RADIATION EXPOSURE ON HIGH ALTITUDE PASSENGER FLIGHTS. Schaefer, Hermann J. (Naval Aerospace Inst., Pensacola, Fla.). Advan. Biol. Med. Phys.; 13: 153-206 (1970).

The sources of ionizing radiations to which passengers of supersonic aircraft cruising at mach 2.2 at 60,000 ft altitude would be exposed are discussed. The contributions of natural background radiation, galactic radiation, solar flares, heavy nuclei, and stratospheric fallout to the radiation dose are considered from the viewpoint of possible deleterious effects on public health. It is concluded that further investigations on the threshold dose for radiation injury and ways to measure threshold dose must be made to insure the radiation safety of passengers during supersonic flight. (66 references) (C.H.)

4759 CHARACTERIZING THE NATURAL β-ACTIVITY OF SOME KINDS OF MINERAL WATER. Yagovoi, P. N.; Davydov, O. V.; Zherdev, G. M.; Aleksandrov, V. N. Vop. Pitan.; 30: No. 3, 62-5(1971). (In Russian).

Studies were made on the radiation dose absorbed by man following the intake of radioactive water. The ^{40}K content in mineral water from 11 sources was independent of the degree of mineralization, but the content of other β-emitters was directly proportional to the mineralization. The total β activity (exclusive of ^{40}K) of the water under study was 3.53×10^{-11} Ci/l. With this activity of the water, the possible integral absorbed dose of man from internal irradiation cannot exceed one mrad after one-year uptake, even when taking into account the presence of ^{226}Ra, ^{90}Sr, and ^{137}Cs. (TSS)

4760 DOSIMETRY AND TESTICULAR METABOLISM OF ORALLY ADMINISTERED TRITIATED THYMIDINE. Dugan, Mary Ann. Philadelphia; Temple Univ. (1970). 82p. University Microfilms Order No. 71-19,952.

Thesis.

Tritiated thymidine is incorporated into cells synthesizing DNA. The highly selective incorporation of tritiated thymidine into DNA results in non-uniform retention of the radioactivity within the cell. The short range of the β particles emitted from tritium results in only partial irradiation of the cell. The relative health hazard associated with ingested tritiated thymidine is difficult to evaluate because of the selective uptake and concentration of absorbed energy. The radiation dose from orally ingested tritiated thymidine was calculated from rats. Two specific activities of tritiated thymidine were orally administered to mature male rats. Radioactivity measurements were determined in urine, plasma, testes, and the acid-soluble and DNA extractions of the nuclear and cytoplasmic components of the testes. No significant difference was found between the data of the two specific activities administered. The kinetics of tritiated thymidine were elucidated from the data obtained. The results suggested a two compartment elimination profile with possible indication of a third compartment extending beyond the time period studied. For orally administered tritiated thymidine the effective elimination half-lives in urine, plasma, and whole testes were two and ten days. The acid-soluble fractions indicated shorter-lived effective half-lives of 1.5 and five days. Analysis of the DNA moiety of the nuclear extracts indicated a different elimination pattern. The radioactive retention in nuclear DNA was essentially constant to some time after day 30. Analysis at day 60 indicated a significant decrease in retained radioactivity. The abrupt drop in measured radioactivity was postulated to be due to the release of mature sperm cells in the 52-day spermatogenesis cycle. The second phase in the elimination of tritium from nuclear DNA had an apparent effective half-life of 72 days. The physical half-life of tritium, 12.26 years, was used in the dosimetric calculations of nuclear DNA for the first 52 days. Concentration of radioactivity extrapolated to time zero in the kinetic analysis of tritium elimination in urine, plasma, testes, nuclear acid-soluble extracts and nuclear DNA fractions was incorporated into the dosimetry. Radiation absorbed dose to the whole body, the critical organ, and to the critical molecule after oral administration of one uCi per gram body weight of tritiated thymidine was calculated. Absorbed doses of 0.58 rads to the whole body, 0.51 rads to the testes, and 54.02 rads to DNA were calculated. A ratio of absorbed dose of whole-body : testes : DNA equalling 1 : 1 : 100 was established. Utilization of the ratio offered a means of approximating relative hazard to the critical molecule from urine bioassay. (Diss. Abstr. Int., B)

4761 CURRENT POSSIBILITIES OF BIOLOGICAL DOSIMETRY. Tuscany, R. (Inst. of Radiation Hygiene, Prague). Cas. Lek. Cesk.; 19: No. 44, 1036-8(23 Oct 1970). (In Czech).

Current knowledge on the application of radioinduced chromosome aberrations to biological dosimetry is briefly discussed. (NSA of Czech.)

4762 METHODS FOR QUANTITATING RADIOACTIVITY IN VIVO, BY EXTERNAL COUNTING MEASUREMENTS. Sorenson, James Alfred. Madison, Wis.; Univ. ov Wisconsin (1971). 134p. University Microfilms Order No. 71-16,101.

Thesis.

Three methods for quantitatively estimating radioactivity in patients by external γ counting were investigated. These were the combined transmission-emission method, ratioing of Compton to photopeak counts, (C/P), and the dual-isotope methods. A general mathematical description of quantitative measurements was obtained, which was then used to assess the possible sources of error in each method. It was found that of all parameters involved, source depth within the patient has the greatest effect, but that this effect can be accounted for by each of the methods studied. Source thickness and uniformity were found to have relatively small effects ($\lesssim$10%), particularly in the (C/P) ratio and dual-isotope methods. Source thickness effects could be accounted for with reasonable accuracy in the transmission-emission method by modification of the equations derived for point sources. In the (C/P) and dual-isotope methods these effects were small enough that they could be ignored, and point source equations could be used. The mathematical analysis was tested in a series of studies involving various radioisotopes in water phantoms measured on a linear scanning device. Good agreement between theory and experimental results was obtained over a wide range of photon energies and in several counting geometries. The combined transmission-emission method and (C/P) method were used to study the distribution and total-body content of radioactivity in a series of patients injected with ^{59}Fe and ^{99m}Tc sulfur colloid. Both methods were found to improve accuracy in total-body counting (absolute error $\lesssim$10%). The transmission-emission method also gave an apparent improvement in accuracy for determining distribution, and reduced overall random errors in total-body counting to about 5% (S.D.), as opposed to 13% for uncorrected data. Distributional accuracy and random error were not found to be improved by the (C/P) method. (Diss. Abstr. Int., B)

4763 IMPORTANCE, PURPOSE, AND METHODS OF EARLY DIAGNOSIS OF INTERNAL RADIOACTIVE CONTAMINATION OF SOLDIERS IN BATTLE. Pulcinelli, M. Miner. Med.; 61: 3981-9(Sep 1970). (In Italian).

The importance of the early detection of internal radiocontamination of soldiers in battle with respect to the health of the individual and the morale of the fighting unit is discussed. Various methods of measuring internal radioactivity were analyzed for ease of use and precision in the field. The spectrometric method, which measures the activity of the biological sample in toto, appeared to be most satisfactory. (J.S.R.)

4764 EFFECT OF PASSAGE OF USEFUL RADIATION THROUGH LUNG TISSUE ON DOSE DISTRIBUTION IN IRRADIATION PLANS IN TELECOBALT THERAPY. Chvojka, Z. (Charles Univ., Prague). Cesk. Radiol.; 24: No. 1, 39-43(Jan 1970). (In Czech).

The dose distribution during the passage of γ rays through lung tissue was studied. Although the corrections of isodoses for the passage of radiation through lung tissue cannot be neglected, the configuration of isodoses is only slightly changed. Resulting isodose plans depend, to a great extent, on the surface of the irradiation fields. When the surface is smooth and perpendicular to the central beam, a correction for the passage through lung tissue is sufficient. When this is not the case, a correction must be made for the curvature of the surface of irradiation fields. As only slight changes occur in the configuration of isodose curves, corrections affecting the central beam are sufficient. (NSA of Czech.)

4765 ABSORBED FRACTIONS FOR SMALL VOLUMES CONTAINING PHOTON-EMITTING RADIOACTIVITY. Ellett, W. H. (Oregon State Univ., Corvallis); Humes, R. M. J. Nucl. Med., Suppl.; 12: No. 5, 25-32(Mar 1971).

The absorbed fraction ϕ is the ratio of the energy absorbed in a given target volume to the energy emitted by a radioactive source. The use of absorbed fractions to calculate the dose from radionuclides within the body has been described. Values are reported of absorbed fractions for photon emitters in relatively small, unit-density absorbing volumes (1 to 500 g) containing either a central point or a uniformly distributed photon source. The purpose of these data is to supplement the tables of adsorbed fractions published in MIRD Pamphlet 3 for absorbing volumes of 300 g and larger. The present data differ in one important respect from absorbed fractions published earlier. In the results given it is assumed that the volume containing the activity is imbedded within a large scattering medium of the same composition. Backscattered radiation from these surroundings is included in the absorbed fractions tabulated. The composition of the unit-density absorbing medium used as an analog for soft tissue is included. The mean free path and the total attenuation and energy-transfer coefficients of the material are listed for the source energies considered. Specific absorbed fractions, the fractions of the emitted energy absorbed per gram of material, were calculated by a combination of Monte Carlo simulation and analytical calculations, and then the absorbed fractions were determined by appropriate integrations. (auth)

4766 DISTRIBUTION OF ABSORBED DOSE AROUND POINT SOURCES OF ELECTRONS AND BETA PARTICLES IN WATER AND OTHER MEDIA. Berger, Martin J. (National Bureau of Standards, Washington, D. C.). J. Nucl. Med., Suppl.; 12: No. 5, 5-23(Mar 1971).

The distribution of absorbed dose around point radioisotropic sources of electrons and β particles, i.e., around sources that emit particles uniformly in all directions and have dimensions that are negligibly small compared with the ranges of the emitted particles, was calculated. Absorbed-dose distributions as functions of distance from the source are tabulated for monoenergetic electron sources at nine energies between 4 MeV and 25 keV, and for 75 β-emitting radionuclide sources. The tabulations were prepared for water and are given in such a form that they can readily be adapted to other media of low average atomic number and arbitrary density. For soft tissue with unit density practically no adjustment of the water data is required. The tabulated results pertain only to a medium with constant density and homogeneous composition and to source-medium configurations in which the leakage of particles across the boundaries of the medium is unimportant. The compilation is theoretical and is based on the electron multiple-scattering theory developed by Spencer. Absorbed-dose distributions for β-particle sources were computed as weighted sums of Spencer's distributions for different source energies, the weighting being proportional to the β-particle spectrum of interest. This combination was done using a computer because extensive interpolation in the data on the characteristics of the β spectra emitted by the various radioisotopes was required. (C.H.)

4767 PROBLEM OF BIOLOGICAL DOSIMETRY IN THE ACUTE IRRADIATION OF MEN. Dvoreskii, L. I.; Pokrovskaya, V. N.; Melnikova, A. E. Radiobiol.-Radiother.; 12: No. 2, 233-41(1971). (In German).

The possibilities of a biological dosimetry of men using the cytogenic study of the peripheral blood and of the bone-marrow are discussed. The authors believe that the cytogenic examination of a culture of peripheral blood is most favorable for the determination of an integrated radiation dose. In the case of non-uniform irradiation, the analysis of chromosomes of bone-marrow cells being aspired from different areas of the body has to be used for the degree of dose distribution. The possibility of biological dosimetry with the estimation of the uniform irradiation is illustrated by two cases of uncontrolled gamma irradiation. (auth)

4768 EVALUATION OF THE SAMPLE ROTATION METHOD FOR THE MEASUREMENT OF GAMMA ACTIVITY IN LARGE INHOMOGENOUS SAMPLES OF BIOLOGICAL MATERIAL. Harmut, Magda; Simonovic, I.; Popovic, S.; Jovanovic, V. (Inst. for Medical Research and Occupational Health, Zagreb. Univ., Zagreb). Arh. Hig. Rada Toksikol.; 21: No. 3, 247-54(1970).

The sample rotation method was evaluated with an instrument partly constructed at the Institute for Medical Research and Occupational Health. The purpose of the investigation was to find the optimal compromise between the sensitivity of the scintillation detector and the measuring error due to the inhomogeneity of the sample. The method was evaluated with ^{85}Sr and ^{47}Ca. On the basis of our experimental data we conclude that for the determination of radioactivity in large samples of biological material a relatively modest instrument accessible to all clinical radioisotope operating institutions can be used. (auth)

Radiation Protection

4769 (AECL-1027(6th Ed.)) HEALTH AND SAFETY ORGANIZATION. Sixth Edition. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). Aug 1971. 50p. Dep. NTIS (U. S. Sales Only).

Programs for health and safety, in particular radiation safety, at Atomic Energy of Canada Limited are summarized. Topics discussed include the derivation of legal authority, establishment of policy, assignment of operational responsibility, and provision of expert advice for management. (C.H.)

4770 (EUR-4651) CONFERENCE ON RADIATION PROTECTION, ROME, ITALY, 10-11 JUNE 1970. Problems of Demarcation of the Controlled Zone in Medical Installations, in Laboratories, and Around Gammagraphy Sources. (European Atomic Energy Community, Luxembourg. Center for Information and Documentation). Jun 1971. 108p. (In French). (CONF-700662).

Three papers were presented on radiation protection measures employed in medical and industrial facilities. The first paper was concerned with problems of demarcation of controlled zones for external irradiation in medical facilities. Some problems considered in this paper were: definition of controlled zone in relation to ICRP recommendations; classification of environments with respect to exposure of professional personnel and non-specialists; use of photographic film dosimeters and other instruments for radiation monitoring; and standards and regulations relating to ambient and individual control of radiation dose. The second paper was concerned with demarcation of controlled zones in the environment of industrial gamma radiography sources. Legal regulations and their consequences were discussed with regard to exposure of professional personnel and adjacent populations. The third paper was concerned with demarcation of controlled zones in laboratories and in medical installations where non-sealed radiation sources are used. Methods of evaluation of possible exposure to internal and external radiation are discussed. A description of the following research contract is appended: final scientific agreement between Professor Biagini, Institute of Radiology of the University of Rome, and the Commission of the European Community on modes of application of the controlled zone concept in medical facilities. (H.L.W.)

4771 (INIS-mf-99) ANNUAL REPORT TO THE DIRECTOR-GENERAL OF HEALTH FOR THE YEAR ENDED 30 JUNE 1970. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 1970. 39p. INIS.

Developments during the year are outlined and activities undertaken are described briefly. These activities include national isotope standardization, standardization of exposure measurements, calibration of clinical dosimeters, and measurement of characteristics of hospital x ray equipment, an advisory service on diagnostic radiology, care and maintenance of radium, radon and radiopharmaceuticals (statistics of handling are tabulated), data collection on environmental radioactive materials, whole-body monitoring, advice and investigations in radiation protection, and a film badge service. Staff activities and publications are listed. (INIS)

4772 (RPD-79) RADIATION HAZARDS IN INDUSTRY. Booth, A. H. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). May 1970. 20p. (CONF-700559-1). INIS.

From Conference of the Canadian Safety Council; Fredericton, Canada (27 May 1970).

Examples of radiation accidents involving a source from a gamma radiography camera are used to illustrate the potential hazards associated with the use of radiation sources in industry. The importance of close regulatory control over radioactive materials is stressed. In Canada all users are under license from the Atomic Energy Control Board, and applications are reviewed by the Radiation Protection Division of the Department of National Health and Welfare. A Dosimetry Service is operated by this division, and a record is kept of the lifetime dose of radiation workers. An area of concern for the future is the safety problems associated with industrial applications of the non-ionizing radiations such as microwaves and lasers. Recent passage of the Radiation-Emitting Devices Act will allow minimum safety standards for equipment to be set. (INIS)

4773 RADIATION PROTECTION. HOW IT BENEFITS THE DENTIST AND HIS PATIENT. Reger, Roy H.; Siek, Robert D.; Sangaline, Michael E. (Colorado State Dept. of Public Health, Denver). J. Colo. Dent. Ass.; 49: 30-8(May 1971).

Radiation protection programs in Colorado relevant to the protection of dentists and patients during dental radiography are reviewed. The provisions of legislation passed in 1967 and revised in 1970 pertaining to radiation protection applicable in dental practice are outlined. (C.H.)

4774 IONIZING-RADIATION STANDARDS FOR POPULATION EXPOSURE. Lieberman, Joseph A. (Environmental Protection Agency, Winchester, Mass.). Phys. Today; 24: No. 11, 32-8(Nov 1971).

The role of the Environmental Protection Agency in the development of radiation protection standards for population exposure is discussed. The impact of nuclear power generation anticipated by the year 2000 on the radiation dose to the population of the USA is estimated. Data are summarized on the radiation dose to the population from natural background, medical diagnostic exposure to x radiation, weapons test fallout, and nuclear power production during 1960 and 1970 and the dose from each source is estimated for the year 2000. Factors that must be considered in establishing environmental standards for radiation exposure of the population are considered. (C.H.)

4775 RADIATION QUANTITIES AND UNITS. ICRU Report 19 1971. Washington, D. C.; International Commission on Radiation Units and Measurements (1971). 21p.

Definitions are presented for radiation quantities and units with emphasis on terms and units used in radiation protection. An absorbed radiation dose index and a dose equivalent index are included. (C.H.)

Safety Procedures

4776 (BRH/DEP-72-3) RADIATION SAFETY IN X-RAY DIFFRACTION AND SPECTROSCOPY. Proceedings of a Conference held on January 6-7, 1970 at the University of Pennsylvania, Philadelphia, Pennsylvania. Moore, Thomas M.; Gundaker, Walter E. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products); Thomas, John W. (eds.) (Pennsylvania Univ., Philadelphia). Sep 1971. 239p. (CONF-700120). GPO $2.00.

The proceedings of a conference on radiation safety in x-ray diffraction and spectroscopy, held at the University of Pennsylvania on January 6-7, 1970, to fill the need for improved communications between users of x-ray diffraction and spectroscopy equipment, health physicists, and governmental agencies with regulatory responsibilities are presented. Radiation safety in the use of the equipment was discussed from the viewpoints of the experimentalist and other user-oriented personnel, individuals concerned primarily with radiation safety, and agencies responsible for developing and enforcing guides, standards, and regulations. (auth)

Civil Defense

4777 (ORNL-4675) TRANSPORTATION SYSTEMS AND DUAL PURPOSE BLAST SHELTERS: FINAL REPORT. Cristy, G. A. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 141p. Dep. NTIS.

A first step toward a full blast shelter oriented civil defense program could involve a change in priority of selection of existing shelters. The 13 million fallout shelters having a Personnel Vulnerability (PV) rating of 71 or 81 (i.e., underground shelters) already located by the National Fallout Shelter Survey (NFSS) could replace more vulnerable shelters. The design of structures to be built for new or expanded transportation facilities in and around the major cities could be modified at small cost and provide additional blast shelters. Such shelters would include stations and tunnels of rapid transit systems, underground garages, highway and railway tunnels, and the abutment of the interchange and grade separations of interstate highways. A study was made to evaluate the availability of these types of shelters to the population of major cities. The procedure used in evaluation and comparison of the data is described. Of the 53 Standard Metropolitan Statistical Areas (SMSA) with population over one-half million in 1960, 44 have provided data on new transportation systems being planned for the next decade. These planned structures could provide 6.5 million blast shelters if the proper changes in design were accomplished before construction starts. The computer program for matching shelters and population geographically is operational and can be used for any assignment problem provided that the geographical distribution of the potential shelters is known. (auth)

Legal Aspects

4778 (RT/PROT-70(12)) ITALIAN REGULATIONS FOR THE HOLDING AND USE OF AND COMMERCIAL OPERATIONS IN RADIOACTIVE SUBSTANCES. Nocera, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1970. 16p. (In Italian). INIS.

A review of legislation governing the possession and use of radioactive materials in Italy is presented. Fissionable materials, source materials, and minerals are not considered. Legislation ranging from the first Italian laws covering peaceful uses of nuclear energy (Dec. 1962) and radiological protection (Feb. 1964) to 1970 is summarized. Supplementary instructions and explanations for better compliance with the laws and penalties for violations are included. (TSS) (Italy)

4779 REGULATIONS FOR CERTAIN FACILITIES HAZARDOUS TO THE ENVIRONMENT. Wasteson, Lennart. pp 191-7 of Miljoevaardens Juridik, Ekonomi och Administration. Stockholm; Natur och Kultur (1968). (In Swedish).

Regulations for avoiding disturbances from roads, railways, airports, nuclear installations and electrical establishments are described. Laws according to nuclear installations such as the Atomic Energy Law, the Radiation Protection Law, the Atomic Responsibility Law, and the Law for safety proceedings at accidents in nuclear installations etc. are very briefly summarized. (Sweden)

4780 LEGAL ASPECTS OF THE UTILIZATION OF RADIATION SOURCES. De Los Santos Lasurtegui, A. (Junta de Energia Nuclear, Madrid). Bull. Droit Nucl.; No. 7, 54-67 (Apr 1971). (In French).

Radiation protection regulations in France are reviewed. The field of application of these regulations, damage prevention, and compensation are discussed. The regulations concern principally the responsibility of the establishment for damage caused and compensation of possible victims. The following points are discussed: the civil liability of the establishment even when it is free from blame; the obligation imposed on the establishment to cover its responsibility by having sufficient insurance; the intervening of the state when the damage is nonindemnized, because it has exceeded the responsibility of the establishment. (auth) (France)

Medicine

Refer also to abstract 6052.

Protective Substances

Refer also to abstracts 4684, 4692, and 4693.

4781 MOLECULAR INTERACTION OF L-TRYPTOPHAN WITH BASES, RIBONUCLEOSIDES, AND DNA. Arcaya, G.; Pantoja, M. E.; Pieber, M.; Romero, C.; Toha, J. C. (Univ. of Chile, Santiago). Z. Naturforsch.; 26b: No. 10, 1026-30 (Oct 1971).

The interaction of L-aromatic amino acids with bases and nucleosides is described. Of these, L-tryptophan interacts more strongly with bases and nucleosides as indicated by nuclear magnetic resonance, circular dichroism, and solubility measurements. A possible ring-ring type interaction between the amino acid and bases or nucleosides is proposed; this interaction being such that the hydrodynamic behaviour of the DNA molecule is unchanged. Ultraviolet irradiated DNA is protected by L-tryptophan. A mechanism of energy transfer from the DNA to tryptophan trough triplet-triplet states is discussed. (auth)

4782 ROLE OF BACTERIAL MEMBRANES IN RADIOSENSITIZATION. Shenoy, M. A.; Joshi, D. S.; Singh, B. B.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Trombay, India). Advan. Biol. Med. Phys.; 13: 255-71(1971).

A review is presented of the role of bacterial membranes in macromolecular synthesis and the importance of the bacterial membrane in the modification of radiation response of cells by extracellular chemicals. A review of mechanisms of radiosensitization includes discussions of short-lived transients, iodine atoms in sensitization, and biochemical consequences of iodination. Biochemical consequences are discussed with regard to enzyme inactivation, DNA synthesis, DNA degradation, and protein synthesis. It is concluded that: sensitization of Escherichia coli to radiation by iodine compounds is ascribed to short-lived transients of the sensitizer; these short-lived transients could be produced on reaction of the sensitizer with either radiation induced or chemically generated hydroxyl radicals and are suggested to be iodine atoms; due to the high reactivity of iodine atoms, all the membrane proteins become iodinated at all amino acid residues; and the sensitization of bacterial cells to radiation by iodine compounds can be ascribed to total protein poisoning due to iodination of the membrane proteins. (H.L.W.)

4783 REACTION OF RADIOPROTECTIVE AMINES WITH PYRIDOXAL. Matsushima, Yoshikazu (Kyushu Univ., Fukuoka); Akaboshi, Sanya. J. Radiat. Res.; 12: No. 1, 37-9(Mar 1971).

The authors present the new postulate that amines that form dissociable heterocyclic compounds with the aldehyde group of pyridoxal in the solutions under physiological conditions have radioprotective activities. The implications of the postulate for some chemical and biological systems are discussed. (auth)

4784 EFFECT OF CYSTEINE-PRETREATMENT ON THE RECOVERY OF THE HAEMATOPOIETIC STEM CELL POPULATION AFTER X-IRRADIATION. Kovacs, P.; Hernadi, F. (Univ., Debrecen, Hungary). Stud. Biophys.; 27: No. 2, 149-55(1971).

The repopulating capacity of the femoral marrow was estimated at several intervals after 150 R whole body x-irradiation in unprotected and cysteine-protected BALB/c mice. Cysteine pretreatment neither shortened the time necessary for the stem cell population to begin recovery, nor accelerated the process of repopulation, but allowed more stem cells to survive. Hence, repopulation started from a higher level in mice pretreated with cysteine than in unprotected ones. (auth)

4785 PROTECTION OF RNA POLYMERASE AGAINST IONIZING RADIATION BY MIXED DISULPHIDE FORMATION. Suemegi, J.; Sanner, T.; Pihl, A. (Norwegian Radium Hospital, Oslo). Int. J. Radiat. Biol.; 20: No. 4, 397-9(1971).

The radioprotection of RNA polymerase of Escherichia coli was investigated by blocking its sulfhydryl groups with cystamine. Solutions of RNA polymerase from E. coli, alone and pretreated with cystamine, were irradiated with doses from 0 to 125 kR, and the remaining enzyme activity measured with calf-thymus DNA and T coliphage DNA as templates. X radiation was 220 kV at a dose rate of 1.75 kR/min and carried out at 4°C in air. Results indicated that the destruction of sulfhydryl groups was responsible for loss of activity, but that when these combined with cystamine to form mixed disulphides, a large degree of protection was obtained. (UK)

4786 IN VITRO PROTECTION AGAINST RADIATION DAMAGE TO TEMPLATE ACTIVITY IN DNA SYNTHESIS. Leon, Shalom A.; Kollmann, George; Shapiro, Bernard (Albert Einstein Medical Center, Philadelphia). Int. J. Radiat. Biol.; 20: No. 4, 337-46(1971).

In vitro protection against radiation-induced functional changes in DNA was studied by measuring DNA template activity in enzymatic DNA synthesis. Exposures up to 28 kR inhibited the priming activity of salmon sperm DNA with E. coli DNA-polymerase, reducing the incorporation of all four deoxynucleotides and altering the incorporation kinetics. The radiation protective agent bis(2-guanidoethyl) disulphide (GED) protected against these changes. GED-protected-DNA exposed to 7 and 14 kR actually showed enhanced template activity, incorporating 20 to 50% more dGMP than the unirradiated control. Partial denaturation of DNA by dissolving in distilled water and complete denaturation by heat, before irradiation, increased the radiosensitivity of DNA. Heat-denaturation of unirradiated DNA did not affect its template activity, but heat-denaturation of DNA previously irradiated in double-stranded form reduced its template activity below that of irradiated undenatured DNA. Denaturation may release inactive fragments produced by radiation-induced single-strand breaks. Radiation alteration of the template resulted in different effects on the incorporation of the different deoxynucleotides, indicating miscoding. GED protected against this effect by tending to maintain the normal deoxynucleotide ratio. CsCl density-gradient equilibrium centrifugation of irradiated DNA showed a shift to higher density, and this was not protected against by GED. This may represent localized denaturation (and cross-linking) and may explain the enhanced DNA template activity, observed under certain conditions. (auth)

4787 CONTENT OF PYRUVIC ACID AND OF LACTIC ACID IN ORGANS OF IRRADIATED RATS AND OF RATS BEING IN A RADIORESISTANT CONDITION AFTER AUTOTRANSPLANTATION OF SUPRARENALS AND AFTER THE INJECTION OF DIMETHYL SULPHOXIDE. Kir'yanov, I. Yu.; Grozdiv, S. P. Radiobiol.-Radiother.; 12: No. 3, 357-69(1971). (In German).

The content of pyruvic acid and of lactic acid was determined in radiosensitive (thymus and spleen) and radioresistant (liver) tissues of irradiated rats and of rats in whom radioresistant conditions were caused by autotransplantation of suprarenals and by the injection of dimethyl sulphoxide (DMSO). Further examinations were made with rats being in these radioresistant conditions during irradiation. Autotransplantation of suprarenals and the injection of DMSO produce, in the protective period, a decrease of the lactic acid content in the spleen and in the thymus and an increase in the liver. Irradiation causes an increase of lactic acid concentration in the spleen and in the thymus already after 1 hr. In the spleen, a decrease of lactic acid content is observed in the course of the first day and an increase on the third day. In the combined effect of irradiation and protective factors, important differences from the norm were not found in pyruvate and lactate content. In earlier examinations, an increase in the lactic acid content was found in the spleen, in the thymus, and in the liver during the period of radioprotection if this was caused by hypoxia or by a so-called biochemical shock in the tissues with cystein, AET, and ATE. In the combination of irradiation with these protective

factors these changes did not appear. Our results show the different protective mechanism in the injection of DMSO and in hypocorticoid conditions compared with the effect of protectors that cause hypoxia or a biochemical shock. Furthermore, the content of pyruvic acid and of lactic acid after the injection of hydrocortisone was examined. Similar changes as after irradiation were observed. It was shown that the protective effect of hypocorticoid conditions and of DMSO is essentially lower than the effect of hypoxia, cystein, and AET. (auth)

Radiodiagnosis

Refer also to abstracts 4544, 4563, 4680, 4753, 4765, 4766, 4773, 4849, and 4874.

4788 (INIS-mf-54) RADIOACTIVE MATERIALS AND RADIOPHARMACEUTICALS. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 8p. (In Spanish). INIS.

The provision of radioactive materials and radiopharmaceuticals is one of the services of the National Commission of Atomic Energy of the Republic of Argentina. This work is extracted from the new catalog of radioisotopes that is in preparation, and constitutes, itself, a list of the important available radioactive materials. (tr-auth)

4789 METHOD OF INTRAVENOUS CEREBRAL ANGIOSCINTIGRAPHY. Haase, Jens; Kalnaes, Ole. Ugeskr. Laeger; 133: 1766-9(1971). (In Danish).

A simple method of visualizing the cerebral vascular system by means of intravenous administration of a non-diffusable radisotope is described. The method is termed intravenous cerebral angioscintigraphy. Obstructive conditions in the carotid arteries, middle cerebral arteries, and disturbances of circulation in the cerebral hemispheres may be diagnosed and examples of the results of investigation are given. The method of investigation is suitable for routine employment and, simultaneously, it supplements the conventional method of cerebral scintigraphy. (auth)

4790 COMPARISON OF ^{133}Xe RADIOSPIROMETRY WITH MOVING DETECTORS AND BRONCHOSPIROMETRY. Korhonen, O.; Poppius, H. (Univ. Central Hospital, Helsinki). Scand. J. Resp. Dis.; 52: 63-6(1971).

Radiospirometry using ^{133}Xe and two pairs of moving detectors was compared with bronchospirometry in regard to right-left distribution of perfusion, ventilation, and vital capacity in 29 patients with various pulmonary diseases. The two methods yielded similar results in ventilation and vital capacity measurements. In the perfusion measurement, radiospirometry yielded significantly higher values than bronchospirometry for lungs with reduced function. (auth)

4791 RADIOISOTOPOVA DIAGNOSTIKA KOSTNICH CHOROB. (Radioisotopic Diagnosis of Bone Diseases). Vokrouhlicka, Olga. Prague; Avicenum-Zdravotnicke Nakladatelstvi (1971). 133p.

Calcium metabolism and mathematical models of bone crystal structure are discussed, together with the use of kinetic indexes in clinical diagnosis using radioisotopes as tracers. The various types of osteoporosis and hormone imbalance associated with bone degeneration are considered. Localized lesions in bones and joints discussed include malignant and benign tumors and metastases, as well as inflammatory conditions. Isotopes used for scintigraphy of bones include ^{47}Ca, ^{45}Ca, ^{85}Sr, and ^{18}F. (500 references.) (TTT)

4792 LOCALIZATION OF ^{85}Sr IN SOFT TISSUE INFECTED BY ASPERGILLUS NIGER. Ray, Gordon R.; DeNardo, Gerald L.; King, Gerald H. (Stanford Univ., Calif.). Radiology; 101: No. 1, 119-23(Oct 1971).

A case of soft-tissue localization of ^{85}Sr in a patient with cancer and aspergillosis is presented. Autopsy tissue specimens revealed that the soft tissues infected by Aspergillus niger had 14 times more radioactivity than comparable uninfected soft tissues obtained from the same patient. In vitro studies using Aspergillus niger isolated from the patient showed that these organisms could bind and concentrate ^{85}Sr. Apparently the soft-tissue localization of ^{85}Sr in this patient was due to Aspergillus niger within these tissues. (auth)

4793 SPECIFIC DETECTION OF LIVER CANCERS USING DOUBLE LABELING WITH SELENOMETHIONINE (^{75}Se) AND COLLOIDAL GOLD (^{198}Au). de Saint-Laurent, Jean; Hadchouel, Paul; Caroli, Jacques; Milhaud, Gerard (Hospital-Saint-Antoine, Paris). Compt. Rend., Ser. D; 272: No. 25, 3221-4(21 Jun 1971). (In French).

The scintigraphic study of the relative concentrations of ^{75}Se-selenomethionine and ^{198}Au colloid allows primary or secondary liver cancers to be safely detected and localized. (auth) (France)

4794 RADIONUCLIDIC IMAGING PROCEDURES IN THE DIAGNOSIS OF CANCER. Quinn, James L. (Wesley Memorial Hospital, Chicago. Northwestern Univ., Chicago). CA - Cancer J. Clin.; 21: No. 5, 292-301(Sep-Oct 1971).

Radionuclide imaging has proved useful in diagnosing cancer of several sites and is used routinely in detecting neoplasms of the thyroid and primary or metastatic neoplasms of the bone, brain, liver, and spleen. Brain and bone scans are most useful for detecting metastases from carcinoma of the breast, colon, or lung. Of the 25 different radionuclides used in diagnostic procedures, only a few are valuable in diagnosing neoplasms. The choice of one of these agents is dictated by the organ or system under study, the method of biological transport of the radionuclide, and its degree of concentration within the organ. New radionuclides become available periodically and short-lived radionuclides, such as ^{18}F and ^{67}Ga, produced by medical cyclotrons are now available. Data are tabulated on 17 radionuclides available for scintigraphy in 1971, their applications, the rationale for their use, the pharmaceutical into which each is incorporated, the range of doses administered, the physical half-life of each, and the detection method used for each. (C.H.)

4795 SCINTILLATION CAMERA WITH PINHOLE COLLIMATOR IN THYROID IMAGING. Hurley, P. J.; Strauss, H. W.; Pavoni, P.; Langan, J. K.; Wagner, H. N. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 101: No. 1, 133-8(Oct 1971).

Thyroid images of 100 patients were obtained following the administration of ^{99m}Tc-pertechnetate using both a gamma camera with a pinhole collimator and a rectilinear scanner with an 8-inch crystal. The pinhole images were better in 64 patients, the scans better in 11, and they were equal in 25. The average quality of the pinhole images was higher than that of the scans. Pinhole studies obtained in 31 subjects without evidence of thyroid disease demonstrated considerable variation in size, shape, and nuclide distribution. The pinhole collimator may produce some distortion, but its superior resolution allows production of high-quality images. (auth)

4796 STUDY OF RENAL FUNCTION IN URINARY SCHISTOSOMIASIS IN IRAQ USING INTRAVENOUS PYELOGRAPHY AND ORTHO IODO HIPPURAN LABELLED WITH RADIOACTIVE IODINE. Muhammed, Kh, H.; Baba, W. I. (Inst. of Radiology and Nuclear Medicine, Baghdad). Isotope Radiat. Res.; 4: 47-52(Jun 1971).

Twenty eight urinary bilharzial patients, 7 to 10 yrs old and 24 normal controls were studied. Intravenous pyelography (I.V.P.) and iodo-hippuran-^{131}I renography were done to all. Findings indicate that, whenever an abnormal finding in the (I.V.P.) is obtained, abnormal finding of one or more parameters of the renography will be obtained too. Although (I.V.P.) findings in eight urinary bilharzial patients were normal, still there were abnormal findings in one or more parameters of their radiorenography. These findings may raise a question for further work on the value of radiorenography as a diagnostic aid of choice in some urinary problems. (auth)

4797 RADIOACTIVE ISOTOPES IN THE CONTROL OF INTRAARTERIAL CHEMOTHERAPY. Erjavec, M.; Auersperg, M.; Obrez, I. (Inst. of Oncology, Ljubljana, Yugoslavia). Radiobiol.-Radiother.; 12: No. 2, 219-25(1971).

The flow of the intraarterially administered chemotherapeutic agents for regional treatment of malignant tumors was monitored by infusions of radioactive particles of sufficient size to embolise in the capillaries. The distribution of the radioactivity was demonstrated by body profile counting and scintillation scanning. Altogether 82 studies in 25 patients showed that this method was more reliable than dye injections for estimating the true flow of the chemotherapeutic agent. In addition, this method affords the observation of arteriovenous shunts that were demonstrable to various extents in most of the observed tumors. It was shown that shunts regularly open wide at the onset of a local toxic reaction due to chemotherapy, thus draining increased amounts of chemotherapeutics into the general circulation and inducing general toxic effects. The method is considered valuable in the management of the intraarterial infusion chemotherapy. (auth)

4798 PROGRAM SYSTEM FOR COMPUTER SCINTIGRAPHY. Potschwadek, B.; Adomssent, S.; Bartsch, H. J. (Univ., Rostock, Ger.). Radiobiol.-Radiother.; 12: No. 2, 197-202(1971). (In German).

A program system for computer scintigraphy is described that starts from a punch tape obtained by means of a scanner. The de-

signed 12 parts of the program permit various corrections of the measuring values, consideration of activity decrease, and temporal activity change in the respective organ. The normalized results are delivered in a symbol matrix according to freely eligible criteria. (auth)

4799 ISOTOPE NEPHROGRAPHY WITH ^{51}Cr-EDTA AND ^{58}Co-DTPA. Mitrov, G.; Salambaschev, L.; Muschmov, D.; Todorov, G. (Institut fuer Arztliche Fortbildung, Sofia). Radiobiol.-Radiother.; 12: No. 2, 191-6(1971). (In German).

Nephrographic examinations with glomerularly filtered substance ^{51}Cr-EDTA and ^{58}Co-DTPA are reported. Compared with hippurate-ING, EDTA-ING has a more flatly running 2nd stage and a delayed 3rd stage that is explained by the quantitative differences between the glomerular filtrate (normally about 100 ml/min) and the effective stream of the renal plasma (normally about 500 to 600 ml/min). It is demonstrated, by means of examples, that early changes of the glomerular apparatus may be diagnosed by EDTA-ING at a time when the usual renal function tests and hippurate-ING show normal findings. Therefore, a broader use of EDTA-ING as a completion of hippurate-ING is recommended. (auth)

4800 DIAGNOSTIC EVALUATION OF ^{67}Ga SCANNING OF LUNG CANCER AND OTHER DISEASES. Ito, Yasuhiko; Okuyama, Shinichi; Awano, Takayuki; (and others) (Tohoku Univ., Sendai). Radiology; 101: No. 2, 355-62(Nov 1971).

Gallium-67 was the scanning agent in 52 studies: 21 of lung cancer, 11 of tuberculosis, 7 of other lung diseases, 4 of esophageal cancer, 6 of breast disease, and a miscellany of other lesions. The scans clearly delineated infraclavicular lymph node metastases difficult to palpate and lesions in the hili and mediastinum difficult to demonstrate roentgenologically. The ^{67}Ga uptake may result from alterations in vasculature and permeability as well as increased metabolism within and around the disease process. (auth)

4801 RADIONUCLIDE STUDIES IN AN UNUSUAL CASE OF DANDY–WALKER CYST. Harbert, John C.; McCullough, David C. (Georgetown Univ. Hospital, Washington, D. C.). Radiology; 101: No. 2, 363-6(Nov 1971).

A case of Dandy-Walker cyst is described in which radionuclides but not air penetrated the cyst and lateral ventricles from a lumbar injection. This case demonstrates the difficulty in differentiating posterior fossa cysts by roentgen techniques. Further studies are needed to determine the role of cisternography in evaluating these cysts. (auth)

4802 SERIAL BRAIN SCANS IN GLIOBLASTOMA MULTIFORME. Quinn III, James L. (Chicago Wesley Memorial Hospital. Northwestern Univ., Chicago. Radiology; 101: No. 2, 367-70(Nov 1971).

Fourteen patients with glioblastoma multiforme who had serial brain scan changes over a period of weeks, months, or years are presented. The initial scan was negative or slightly positive, but later scans were strikingly positive. Changes seen over a period of months may be the result of the malignant glioma growing from the less vascular white matter to the more vascular stroma in the gray matter. Changes over a period of years may represent malignant degeneration in a benign astrocytoma. No clear-cut explanation for rapid changes over a period of weeks is known. (auth)

4803 ^{99m}Tc-HUMAN ALBUMIN MICROSPHERES (HAM) FOR MEASURING THE RATE OF GASTRIC EMPTYING. Calderon, Marcos; Sonnemaker, Robert E.; Hersh, Theodore; Burdine, John A. (Baylor Coll., Houston, Tex.). Radiology; 101: No. 2, 371-4(Nov 1971).

The radiopharmaceutical HAM (^{99m}Tc-human albumin microspheres) was used to measure gastric emptying time in a series of 29 patients (normal, 9; duodenal ulcer, 7; gastric ulcer, 7; and gastric carcinoma, 6). The mean emptying rate in each group of patients was significantly different, as was the pattern of emptying. No overlap occurred in the T-50% results for one standard deviation. The physical properties of ^{99m}Tc-HAM permit the administration of relatively large amounts of the radionuclide, creating a high photon flux that results in excellent scintillation camera images. This technique is reproducible, and tests show less than 2% absorption of the radionuclide. (auth)

4804 CEREBROSPINAL FLUID SCANNING WITH ^{111}In. Matin, Philip; Goodwin, David A. (Veterans Administration Hospital, Palo Alto, Calif. Stanford Univ., Palo Alto, Calif.). J. Nucl. Med.; 12: No. 10, 668-72(Oct 1971).

Indium-111 is now available for radionuclide procedures in humans. This cyclotron-produced radionuclide decays by electron capture with a half-life of 2.8 days. There is no beta emission, and 1.8 gamma rays useful for scanning are emitted per disintegration. Radiopharmaceuticals using this nuclide have been developed for cerebrospinal fluid scanning because of the almost ideal half-life and decay scheme. An indium-transferrin complex, using the patient's own serum, has been used in animals and in one human. This radiopharmaceutical has been shown to follow the natural CSF pathways delineated by ^{131}I-iodinated human serum albumin (IHSA) and therefore appears to be useful for routine CSF scanning. Colloids such as indium phosphate colloid collect at the region of the basal cisterns and are unsatisfactory for cisternography. (auth)

4805 THYROID SCINTIPHOTOGRAPHY IN 1000 PATIENTS: RATIONAL USE OF ^{99m}Tc AND ^{131}I COMPOUNDS. dos Remedios, Leo V.; Weber, Paul M.; Jasko, Ivan A. (Kaiser Foundation Hospital, Oakland, Calif.). J. Nucl. Med.; 12: No. 10, 673-7 (Oct 1971).

A review of results on 1000 patients showed that the best method for routine imaging of the thyroid is ^{99m}Tc scintiphotography. Its merits are: low thyroid radiation dose, technical simplicity and speed, and consistent yield of good thyroid images. Scintiphotography with ^{131}I should not be performed routinely but should be reserved for reimaging after ^{99m}Tc failure where, because of poor uptake and/or large goiter, the thyroid radiation dose may be much less than usual. Iodine-131 should also be used to evaluate all ^{99m}Tc hot nodules, to diagnose substernal or ectopic activity, and to define equivocal cold nodules. Only ^{131}I should be used for the postoperative management of thyroid carcinoma. (auth)

4806 CISTERNOGRAPHY WITH ^{169}Yb-DTPA. DeLand, Frank H.; James, A. Everette Jr.; Wagner, Henry N. Jr.; Hosain, Fazle (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med.; 12: No. 10, 683-9(Oct 1971).

Although the cerebrospinal fluid (CSF) is probably formed in many regions of the subarachnoid space, the bulk of CSF is produced in the choroid plexuses of the third and lateral ventricles. The normal direction of flow is from the ventricular system into the subarachnoid spaces surrounding the brain stem, spinal cord, and brain, finally concentrating in the parasagittal area. For radionuclide cisternography the radiopharmaceutical is usually introduced into the lumbar intrathecal region and from this point the activity can be followed from the spinal canal to the parasagittal regions where it is absorbed. On the basis of the relatively constant flow pattern of cerebrospinal fluid, radionuclide cisternography reflects: the movement of spinal fluid through the subarachnoid space; absorption of spinal fluid from the cerebrospinal spaces into the vascular and extravascular spaces; and entry and exit of spinal fluid into or from the ventricular system under pathologic circumstances. Results are summarized on 125 cisternograms performed using ^{169}Yb-Ca-diethylenetriaminepentaacetic acid (DTPA) as the radiopharmaceutical. In the majority of cases, the radiopharmaceutical was injected into the lumbar intrathecal space. Radionuclide images of the brain were routinely performed in the anterior, posterior, and both lateral positions. When indicated, vertex views were obtained as well as other views such as the spinal region or abdomen when dictated by the specific requirements of the patient. (C.H.)

4807 EFFECT OF PULSE-HEIGHT SELECTION ON LESION DETECTION PERFORMANCE. Rollo, F. D.; Schulz, A. G. (Johns Hopkins Medical Institutions, Baltimore. Johns Hopkins Univ., Silver Spring, Md.). J. Nucl. Med.; 12: No. 10, 690-6(Oct 1971).

Systematic measurements of the effects of energy-window selection on fluctuation noise, resolution, and contrast in radioisotope scan images have been lacking, and no measurements have been made of the resultant effects on observer performance in detecting lesions. Experimental results were used to generate simulated scans for observer tests to show how energy-window selection affects an observer's ability to detect the presence of a lesion in a scan. (auth)

4808 ARTIFACTS IN ^{99m}Tc-SULFUR COLLOID LIVER SCANS. Hernberg, J. C.; Braunstein, P.; Chandra, R.; Blum, M. (New York Univ., N. Y.). J. Nucl. Med.; 12: No. 10, 697-8(Oct 1971).

The advent of the frequent use of ^{99m}Tc-pertechnetate for brain scanning and ^{99m}Tc-sulfur colloid for liver scanning has led to the possibility of artifacts in the scan when activity from a previous scan remains in the patient. This situation is most likely to occur in patients transferred from one institution to another. Two instances of artifacts in ^{99m}Tc-sulfur colloid liver scans due to residual activity from ^{99m}Tc-pertechnetate brain scans are reported. (C.H.)

4809 EXAMINATION OF THE GLOMERULAR FILTRATION BY MEANS OF THE RADIOACTIVE PREPARATIONS ^{131}I-TRIOMBRIN, ^{51}Cr-EDTA, AND ^{169}Yb-EDTA. Zubovskii, G. A.; Frenkel, V. Ch.; Markova, E. G. Radiol. Diagn.; 12: No. 1, 69-79(1971). (In German).

A comparative analysis of the use of different preparations for the examination of glomerular function is given. Determinations of the minute volume of the glomerular filtration (MVGF) by means of different methods and preparations revealed that the absolute values of the minute volume are not identical but that they are well comparable with each other. Therefore, that method has to be preferred that is less handicapping for the patient, that is the external measurement of activity (gammagraphy). It could be found that ^{169}Yb-EDTA has some advantages leading to statistically more reliable results. The radiation dose with the use of ^{169}Yb EDTA is virtually not higher than with ^{51}Cr-EDTA and essentially lower than with examinations by ^{131}I triombrin. (auth)

4810 ADVANTAGES OF THE USE OF ^{133}Xe FOR GAMMA-MYELOGRAPHY. Lyass, F. M. Radiol. Diagn.; 12: No. 1, 141-5(1971). (In German).

The diagnostic possibilities of the use of radioactive solutions and of radioactive gases for gamma-myelography are analyzed. A comparison of the radiation dose by the use of different radioactive isotopes is given. On the basis of vast experience and detailed evaluation of the literature, it was concluded that ^{133}Xe had incontestable advantages for gamma myelography. (auth)

Radiotherapy

Refer also to abstracts 4764, 4833, 4843, 4869–4873, 4875–4877, and 4879.

4811 (UCRL-73456) CANCER RADIOCHEMOTHERAPY WITH 7-TRITIOTETRACYCLINE: RATIONALE AND PRELIMINARY ANIMAL RESULTS. Wood, Paula; Haury, John; Wood, Lowell (California Univ., Livermore. Lawrence Radiation Lab.). 30 Aug 1971. 23p. (CONF-710809-9). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

A rationale for the study of the radiochemotherapeutic efficacy of tetracycline, heavily labeled with tritium in the 7-carbon position, in malignancy treatment is presented. Preliminary results of studies of the tissue distribution of tetracycline in normal and tumor-bearing rats are reported. Results are not yet conclusive, but this radiochemotherapeutic approach yielded basically positive results in a reasonably conservative model system. It is concluded that eventually tritium-labeled tetracycline may have utility in high-risk cases of human malignancy. (C.H.)

4812 ADVANCEMENT OF BIOLOGY. VOLUME II. DOSE FRAGMENTATION IN RADIOTHERAPY. Symposium of the National Association of Italian Medical Radiobiology, Rome, September 30, 1967. Martinenghi, C.; Castellani, A.; Bergonzi, M. (eds.). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 1-262(1967). (In Italian). (CONF-6709100).

Separate abstracts were prepared for each of the ten papers presented in the symposium. (E.R.B.)

For abstracts of individual papers see: 4813–4816, 4829, 4830, 4843, 4844, 4871, and 4872.

4813 TIME FACTOR IN RADIOBIOLOGY AND RADIOTHERAPY. Turano, L. (Univ., Rome). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 1-22(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

Following a brief statement, based on classical radiobiology, concerning the time factor in radiobiology and radiotherapy, the exact meaning of the factor is determined on the basis of current research. The importance of the oxygen factor is discussed and the results of some experimental models based on cellular heterogeneous and clonal populations at different stages of oxygenation are given. The time factor is related to the radiosensitivity of the irradiated subject, and its quantitative values are used in the application of radiations to clinical procedures. Another parameter of the time factor is the chronological distribution of the radiation energy in normal human tissues in relation to pathological tissues. Applications of the time factor in tumor therapy are still difficult because of the specific clinical autonomy of each tumor and the variabilities and obscurities relating to their pathology. Some proposals for improving the application of the time factor in radiotherapy are given, particularly in reference to clinical experiences and the introduction of high energies. These have likely improved the temporal electivity of the neoplastic cells in relation to healthy tissues. Based on a few attempts made 10 yrs ago, in which smaller total doses than normal were used, a working hypothesis for further experiences in the clinical field is made. However, the difficulties involved in clinical observations and the extreme variability in the biological components of each tumor make such observations very uncertain. Therefore, a closer collaboration between radiobiological investigations and clinical radiotherapeutic experiences is recommended. (E.R.B.)

4814 MEANING OF DOSE FRACTIONATION IN RADIOTHERAPY. Perussia, A. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 79-103(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

In the radiotherapy of malignant tumors, the radiologist must search for a compromise between two contrasting requirements; on the one hand he has to seek the extinction or at least the regression of the malignant cellular population and on the other he has to avoid in the best possible way any damage to the non-tumorous tissues as well as to the normal components of the tumor in order not to jeopardize the capabilities of local repair and general recovery of the patient. In order to achieve these results, one has, in the first place, to choose appropriately the irradiation technique, with the aim of obtaining the best space distribution of the dose as allowed by the anatomical and clinical situation and by the available instrumentation. Secondly, with the same aim, it is necessary to exploit the differences in biological response to irradiation among cells and among different tissue structures. Under this respect, in the conventional radiotherapy techniques (using electromagnetic radiations and fast electrons) the time distribution of the irradiation is of special importance. First the author surveys the most important results obtained by experimental biology in the study of the effects of ionizing radiations on mammal cells and on cell populations both in vitro and in vivo and mentions the interpretation schemes proposed for a theoretical systemization of these results in terms of population kinetics. Then he shows how these interpretation schemes give a plausible justification for the importance that the dose fractionation may have in the radiotherapy of malignant tumors and suggest interesting hints for a critical revision and a better readjustment of the conventional fractionation techniques. After having discussed the most promising working hypotheses allowed by the recent experimental results in this field, the author emphasizes the expected possible differences in the search for an optimum fractionation, between the conventional radiotherapy techniques and others that only now begin to be applied in the clinical field, like the radiotherapy in hyperoxygenation and in hypooxygenation as well as the techniques using protons or fast neutrons. Then the author goes over analyzing the reasons for the greater complexity characterizing the conditions of the radiotherapy as compared with those of the experimental research, pointing out some judging criteria to be used in the choice of the fractionation according to the characteristics of the tumor and the clinical situation in the given case. The author concludes on the one hand stressing the importance of the contributions coming from new ideas and work reaffirming that the clinical experimentation is not replaceable in its search for an always firmer control of the radiotherapy techniques and for a desired improvement of the therapeutic results. (auth)

4815 POSSIBLE RADIOTHERAPEUTIC USE OF RECENT CONTRIBUTIONS OF EXPERIMENTAL RADIOBIOLOGY. Biagini, C. (Univ., Sassari, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 193-210(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

Discussion will be made of main principles in the progress of radiotherapy of malignant tumors illustrating the influence of recent knowledge from experimental research on choosing irradiation methods in tumor therapy. Among new data from experimental radiobiology are quantitative models of irradiation of mammalian cells in vitro; inactivation curves; sublethal damage and its repair; and interpretation models referring to repair and progression. The survival of fractionally irradiated cells will also be examined in model form, reviewing the knowledge of repopulation phenomena in normal and neoplastic tissues. From experimental results above mentioned, practical considerations are derived on unconventional criteria of utilization of the time factor that could be applied in radiotherapy. Some of these criteria are briefly discussed and possible limitations to the use of new models in clinical practice are examined at the level of experimental models analyzed for radiotherapy of malignant tumors. At the experimental level, the author refers to the degree of validity of single experiments, the significance of the clonation techniques, the differences resulting from cell irradiation in vitro and in vivo, the inhomogeneity of irradiated cell populations,

the oxygenation degree of neoplastic tissue, and the role of cellular repopulation. For therapeutic use, practical problems are examined: the still limited knowledge of quantitative aspects of human tumors, their high variability, physical factors such as the space distribution of the dose, the reaction of surrounding tissues, humoral factors, and the probability of metastases. About the problem of neoplastic cell population behavior compared to normal, the author summarizes the useful information on tumors to adequate the fractioning of the dose to concepts deriving from experimental models. Until such data are available, the problems of practical application of new informations still remain those familiar to radiotherapists for over half a century. (auth)

4816 RESULTS OF FRACTIONATION OF THE DOSE IN CLINICAL RADIOTHERAPY. Lenzi, M. (Univ., Modena, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 211-36(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

A discussion of the results of fractionated radiotherapy as compared to standard radiotherapy is presented. A statistical analysis of clinical results presents notable and often insurmountable difficulties such as posteriori evaluations and clinical impressions rather than precise data quantitatively and objectively estimated. Discussion is limited to the behavior of primitive pulmonary cancer and esophageal cancer in an attempt to consider a large and sufficiently homogenous case list. Of the many methods of fractionated therapy, a regrouping was attempted along three basic methods (standard, fractionated, and split-course therapy). Reference is made to published data. The same study has been made on the case lists of the Modena Institute of Radiology concerning survival time in the two kinds of chosen neoplasm, comparing case histories of patients treated with type I, II, or III. While present conclusions confirm those expressed by the author in 1963 for lung cancer, not attaining statistical significance, such indication is however documented for esophageal tumors, pointing out a longer survival in forms treated with split-course therapy. (auth)

4817 TIME-DOSE-VOLUME RELATIONSHIPS IN THE TREATMENT OF GLIOBLASTOMA MULTIFORME. Aristizibal, Silvio A.; Caldwell, William L. (Vanderbilt Univ., Nashville). Radiology; 101: No. 1, 201-2(Oct 1971).

Seventy-four patients with glioblastoma multiforme were treated with ^{60}Co γ radiotherapy; all but five also underwent prior craniotomy. Split-course radiation treatments produced less favorable results than conventional fractionation, particularly when high doses were employed. Short-term survival was not improved by this approach. Total doses of 1,400 to 1,700 rets yielded the best survival rate. (auth)

4818 CONTOUR MAKER ELIMINATING BODY CASTING IN RADIOTHERAPY PLANNING. Kuisk, Hans (Veterans Administration Hospital, Minneapolis. Univ. of Minnesota, Minneapolis). Radiology; 101: No. 1, 203-4(Oct 1971).

A multirod contour maker which replaces plaster-of-Paris or plastic material body casts and unreliable lead wire for exact radiation dosage calculation by isodose curves is described. Composite body contours from supine and prone positions can be made quickly in the proper midrespiration phase, presenting the average body dimensions during the treatment. (auth)

4819 BLOCKING CONSIDERATIONS IN MANTLE THERAPY. Maruyama, Yosh; Khan, Faiz M. (Univ. of Minnesota, Minneapolis). Radiology; 101: No. 1, 167-73(Oct 1971).

The clinical courses of selected patients treated with mantle ^{60}Co γ therapy for Hodgkin's disease over a four-year period are outlined, and selected case studies presented. Among patients with mediastinal disease, recurrence was common, mostly in two areas: the geometric penumbra zone of the field or adjacent to the pair of blocks used to protect the lungs from the radiant beam. Individualized shielding, attention to technique, and dosimetry of the field are essential to therapy. A reference point for dosage is useful in specifying prescribed dose. Booster doses relative to the reference dose can be specified, but will differ according to the point selected. (auth)

4820 EFFECT OF CHEMOTHERAPY AND/OR HEAD IRRADIATION ON SURVIVAL OF MICE WITH INTRACRANIAL GLIOMA. Thomson, James M. Jr.; Maruyama, Yosh; Schwartz, Samuel; Hahn, Eric (Univ. of Minnesota, Minneapolis). Radiology; 101: No. 1, 187-94(Oct 1971).

Mice bearing intracranial gliomas were treated with BCNU (1,3-bis(chloroethyl)-1-nitrosourea), Ara-C (cytosine arabinoside), and copper hematoporphyrin with and without head x irradiation. The strongest effect was noted with BCNU, as would be expected from brain-barrier and cell age-specific activity of the drug. (auth)

4821 RADIOTHERAPY OF GLUTEAL INJECTITIS. Krepsz, I.; Blau, M. (Medical and Pharmaceutical Inst., Tirgu-Mures, Rumania). Radiobiol.-Radiother.; 12: No. 2, 161-4 (1971).

The importance and role of x-ray treatments in cases involving inflammations due to intragluteal injections of drugs are discussed. Among the 76 patients suffering from injectitis, 25 exhibited acute process, 15 subacute, and 36 chronic forms. As for the injected medicines incriminated for generating injectitis, these were mainly antibiotics, hormones, analgesics, and vitamins. The patients are divided in three groups, in function with the evolution of the disease, emphasis being laid on the necessity for the individualization of the therapy, according to the clinical course of the disease. The results obtained justify the application of this therapeutic method in cases of injectitis, achieving restitutio ad integrum in all of our cases, with subsequent incision in 30 to 50% of our cases, required for groups II, namely III. It is recommended to bring into harmony the indications for radiotherapy with the rules referring to the protection of the individual, as well as the population at large against possible radiogenic, genetic hazards. (auth)

4822 MOULAGES OF SILICONE–GUM FOR CONTACT THERAPY OF MALIGNANT VAGINAL TUMORS. Grossmann, H. (Bezirkskrankenhauses, Karl-Marx-Stadt, Ger.). Radiobiol.-Radiother.; 12: No. 2, 165-71(1971). (In German).

The working method is reported by which it is possible to produce vaginal moulages of commercial silicon-gum being used in dentistry, in one operation. These may achieve an optimum dose distribution for the treatment of malignant vaginal tumors by the inclusion of gamma-ray emitters. (auth)

4823 TREATMENT OF CANCER OF THE VULVA WITH HIGH ENERGY ELECTRONS. Frischbier, H. J.; Thomsen, K. (Univ., Hamburg). Amer. J. Obstet. Gynecol.; 111: No. 3, 431-5(1 Oct 1971).

Cancer of the vulva was treated in 118 patients by local electron irradiation including the inguinal lymph nodes. Twenty-eight per cent of these patients were grouped in Stage I or II, and 72% were in Stage III or IV. Serious complications after treatment were observed in 8%. The five-year survival rate was 47.5%. The results of electron treatment are compared with those of surgical techniques. (auth)

4824 X-RAY IRRADIATION OF THE LARYNGEAL CANCER WITH SPECIAL TANGENTIAL FIELDS PROTECTING THE SKIN. Marzecki, Z. (Medical Academy, Szczecin, Poland). Radiobiol.-Radiother.; 12: No. 3, 275-8(1971).

A special technique of irradiation of laryngeal cancer is described. Four oblique fields are used. The x-ray beams are directed tangentially under the surface of the skin. For proper localization of the fields, the applicators are provided with special plexiglass plate. This technique of irradiation gives excellent dose distribution and allows diminution of the dose to the skin. Dose distribution roughly resembles megavoltage therapy. (auth)

4825 AFTERLOADING IN THE INTERSTITIAL IRRADIATION OF THE TONGUE AND THE FLOOR OF THE MOUTH. Marzecki, Z.; Mozolewski, E.; Jelonek, W.; Meyer, A. (Medical Academy, Szczecin, Poland). Radiobiol.-Radiother.; 12: No. 3, 279-82(1971).

A brief description of the afterloading technique in the interstitial irradiation of the cancer situated in two-third anterior parts of the tongue and the floor of the mouth is presented. For the treatment, ^{60}Co wires were used. Some advantages of the afterloading technique in comparison with the conventional insertion of the radium needles are emphasized. (auth)

4826 EARLY OBSERVATIONS ON THERAPEUTIC INTERSTITIAL IMPLANTATION OF ^{192}Ir. Danczak, Zofia (Inst. of Oncology, Warsaw). Radiobiol.-Radiother.; 12: No. 3, 305-9 (1971).

The method of afterloading using ^{192}Ir for interstitial treatment of neoplasms introduced 30 months ago enables the exposure of personnel to radiation to be reduced. Moreover, this method is a considerable improvement to the technique of interstitial radiotherapy owing to the possibility of radiological control during the application and to dosimetry based on the calculation of isodoses in the tissue block to be treated. So far, 80 patients were treated by this method, including cases of oral carcinoma (25), lower lip carcinoma (39), skin cancer (7), and penile cancer (9), and 39 of these cases were followed up for one year at least.

Local failures occurred in two cases of carcinoma of the tongue and in two cases of penile cancer. Moreover, in ten cases severe necroses developed and in five cases limited necrosis of the tissues could be healed using pharmacological means. In most cases (31 out of 39), the cosmetic and functional results were very good. (auth)

Blast and Thermal Effects

Refer also to abstract 4863.

4827 (DASA-2707) EFFECTS OF EXHAUSTIVE EXERCISE ON RATS AT VARIOUS TIMES FOLLOWING BLAST EXPOSURE. Technical Progress Report. Yelverton, John T.; Viney, John F.; Jojola III, Ben; Jones, Robert K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). 1 Apr 1971. Contract DA-49-146-XZ-359. 26p.

A series of four swim experiments using a 20°C water bath was conducted with female, albino rats, Sprague Dawley strain, to investigate the effects of exhaustive exercise on rats at various times after exposure to airblast, determine a time when exercise ceases to influence the mortality of blast-injured animals, and estimate the recovery time required after blast trauma before maximum or near-maximal exercise capability is restored. It was found that rats which were forced to swim to exhaustion as late as one hour following exposure exhibited a fourfold increase in lethality over non-exercised rats exposed to the same blast levels, and that exercise continued to exert an influence on blast lethality at four hours following exposure. However, the added stress of swimming did not increase lethality at 24 hours or seven days. A near-normal swim performance was apparent at seven days after traumatization. (C.H.)

4828 (DASA-2710) BLAST DISPLACEMENT OF PRONE DUMMIES. Fletcher, E. R.; Richmond, D. R.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). 1 Jun 1971. Contract DASA-01-68-C-0118. 30p. (POR-LN-402).

Dummies were placed prone on the surface at ground ranges of 560 and 650 feet from a 500-ton charge. Dummies were also placed in slit trenches at these ranges. The overpressure measured at the 560- and 650-foot range was 37 and 21 psi, respectively, and significantly less than anticipated. The dummies on the surface were displaced from 21 to 73 feet by the blast and the peak velocities were estimated to be from 31 to 70 feet per second. The side-on dummies were translated farther than the end-on ones at corresponding ranges. The dummies remained in the slit trenches without undergoing significant movements. Dummies deviated to the left of the radial line from ground zero because of nonradial winds associated with the anomalous detonation. Reasonable agreement was found between the predicted displacements based on an existing model and the available data. (auth)

Radiation Effects on Animals

Refer also to abstract 4784.

4829 DIFFERENTIAL RADIOSENSITIVITY DURING THE CELLULAR CYCLE. Monesi, V. (CNEN, Rome. Univ., Siena, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 1, 23-51 (1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

At least five types of radiation response of mammalian cells show considerable quantitative variations relative to the position of the irradiated cell through the mitotic cycle: cell survival; chromosome aberrations; mitotic delay; depression of the rate of DNA synthesis; and capacity of the cell to reach the first mitosis following irradiation. The study of the relation between radiosensitivity and the cell cycle was favored by the development of synchronization procedures with cell lines cultivated in vitro, and by the use of specific tracers for DNA. Most of the results on the survival of partially synchronized mammalian cells cultivated in vitro demonstrate a peak of sensitivity during mitosis and a progressive reduction of sensitivity during the phase of DNA synthesis (S). The pattern of sensitivity during the pre-synthetic (G_1) and the post-synthetic (G_2) stages varies considerably in the different cell types according to different authors. The G_1 stage shows a peak of resistance during the initial phase, followed by a sharp drop of the survival as soon as the cells enter the S stage, in human HeLa cells and in the spermatogonia of the mouse irradiated in vivo, but is on the contrary a stage of maximum sensitivity in Chinese hamster cells. The majority of the results obtained demonstrate that both parameters of the survival curves, the slope of the curve and the extrapolation number, vary during the cellular cycle, often inversely between each other. In the majority of cases there is not a clear correlation between changes in sensitivity to lethal effects and changes in sensitivity to other cellular effects by radiation (chromosome aberrations, mitotic delay, inhibition of DNA synthesis) in the course of the mitotic cycle. In most cellular types thus far investigated, the frequency of chromosome aberrations and the duration of the mitotic delay increase progressively from G_1 through S to G_2. The depression of the rate of DNA synthesis is maximum in cells irradiated in S which undergo a marked prolongation of the period of synthesis. From the results summarized above, it is apparent that the response of an asynchronous population of cells depends not only on the survival values of the sub-populations with different sensitivity, but also on the relative proportion of cells in the various phases of the cycle. This factor is important in experiments of fractionation of the dose, since irradiation may produce a selective killing of cells that are in more sensitive stages and a partial synchronization of the population in particular stages of the cycle, which may influence the response to the subsequent exposure to radiation. A typical case of variation in sensitivity of a cell population as a result of a modification in duration of the stages of the division cycle is that described by us several years ago regarding the germ cells of the mouse. The process of differentiation of the spermatogonia in the mouse is characterized by a progressive lengthening of the stage of DNA synthesis (sensitive stage) and a shortening of the G_1 stage (resistant stage) of the cycle. These changes of the relative duration of the various stages may be the mechanism responsible for the progressive increase of sensitivity to radiation during the process of maturation of spermatogonia and of the heterogeneity in sensitivity of immature spermatogonia (type A), observed by many authors. (auth)

4830 REPAIR OF RADIATION DAMAGE AT CELLULAR AND SUBCELLULAR LEVEL. Castellani, A. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 105-23(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967)

Experimental data are reported demonstrating the existence of repair phenomena in damage credited to cellular DNA caused by both ultraviolet radiation (dimers of the thymine) and by ionizing radiation (rupture of the polynucleotidic chain) in which the mechanism of action is illustrated. These phenomena were studied on relatively simple organisms such as bacterial cells, as well as on human and mammalian cells. Regarding the mechanism of action of the phenomena above reported, it was thought that if molecular damage from ultraviolet radiation was different from that of ionizing radiation, at the repair level they were similar and the same repair processes could operate in both cases. The damage credited to DNA, which is considered a potentially lethal damage, is repaired by an enzymatic mechanism, dependent therefore on the metabolic activity of the cell. Because of this, it differs substantially from another type of damage, so called sub-lethal, that was studied with the technique of fractioning of the doses. The repair that acts on this second type of damage in which the DNA does not seem involved is almost completely independent of the temperature and of the cellular metabolic activity. It is supposed that both types of repair are necessary if the cell is to survive the damages caused by the radiations. (auth)

4831 THEORY OF RADIATION EFFECT ON CELL POPULATIONS IN INTESTINAL EPITHELIUM. Sato, Fumiaki (National Inst. of Radiological Sciences, Chiba, Japan); Shiragai, Akihiro; Hiraoka, Takeshi; (and others). J. Radiat. Res.; 12: No. 1, 1-6(Mar 1971).

Some simple mathematical models were developed to analyze the kinetics of the cell populations in the intestinal epithelium after an exposure to ionizing radiation. For the proliferative cells in crypt a logistic proliferation was assumed and for the functional cells in villus the compartment was assumed to be a first in-first out type. A feed-back mechanism is introduced between the two compartments. Mechanisms of the effects of radiation on the system were considered by cell deaths, including delayed deaths, and by mitotic delay. The calculated results showed reasonable amount of over-shoot in the cell numbers in the recovery period and were in general consistent with the experiment. (auth)

4832 EFFECT OF X RAYS ON THE ZETA POTENTIAL OF YOSHIDA ASCITES TUMOR CELLS. Raimondi, L.; Ricci, L. Basso (Univ., Pavia, Italy). Boll. Soc. Ital. Biol. Sper.; 47: No. 9, 241-4(15 May 1971). (In Italian).

The modifications of the electrokinetic potential of Yoshida ascites tumor cells were determined more precisely in white rats x-irradiated with 500 and 1000 R to the abdomen. The re-

sults showed that 24 hr after irradiation the ζ potential was reduced 22.4% from that of the non-irradiated controls. At 48 hr after irradiation, the reduction was 15.16%, and 5.56% after 72 hr. (J.S.R.)

4833 SURVIVAL OF INTESTINAL CRYPT CELLS AFTER FRACTIONATED EXPOSURE TO X RAYS AND 15 MeV NEUTRONS. Broerse, J. J.; Roelse, H. (TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol.; 20: No. 4, 391-5(1971).

Data are given for the survival of mouse intestinal crypt cells after irradiation with 15 MeV neutrons and 300 kV x rays, given as single doses or fractionated doses five times a week. For neutron doses of 220, 280, and 340 rads per fraction, RBE values of 2.1, 1.95, and 1.85 were obtained, compared with the RBE of 1.4 found at a single dose of 920 rads. The RBE values were compared with available data for the effectiveness of 15 MeV neutrons on experimental tumors (mouse osteosarcomas and rat rhabdomyosarcomas) and human kidney cells. The RBE values for normal tissues were lower than those obtained for the tumors irradiated with equal doses per fraction. It was concluded that overall gain factors, $RBE_{(tumor)}/RBE_{(normal\ tissue)}$, of between 1.1 and 1.3 were obtained for fast neutrons relative to x rays. (UK)

4834 BIOLOGICAL ACTIVITY OF EXPLANTATES OF JENSEN-SARCOMA OF THE RAT IN VITRO AFTER THE ADDITION OF ORGANIC EXTRACTS OF IRRADIATED RATS. Wagner, H.; Pradel, I. (Humboldt Univ., Berlin). Radiobiol.-Radiother.; 12: No. 3, 353-6(1971). (In German).

The influence of serum and organofiltration of whole-body irradiated rats on explantates of Jensen-sarcoma is reported. Serum and filtrates of testes, spleen, and liver stop or favor the migration of tumor cells in dependence on the time after irradiation. The effect of organofiltration is contrary to that of the serum that stops the migration during 7 days after irradiation. The filtrates obtained from the organs have a stimulating effect up to the fifth day after irradiation. (auth)

Invertebrates

Refer also to abstract 4898.

Vertebrates

Refer also to abstracts 4493–4495, 4684, 4689, 4691, 4697, 4699–4701, 4706, 4760, 4787, and 4892–4895.

4835 (LBL–348) RADIATION AND DEGRANULATION STUDIES ON UVEAL MAST CELLS. Price, James (California Univ., Berkeley. Donner Lab. California Univ., Berkeley. Lawrence Berkeley Lab.). 27 Aug 1971. Contract W-7405-eng-48. 50p. Dep. NTIS.

Thesis.

Origin and function of the tissue mast cell remain unsolved problems. In part this has been due to the problems found in attempting to establish adequate counting methodology. Tissue mast cells have usually been counted with the assumption that a Poisson distribution would fit their arrangement in tissue, and yet, an evident correlation exists with such tissues as blood vessels and nerves that do not have this distribution. Free peritoneal mast cells can be quantitated more accurately, but their existence outside tissue presents a classification problem. Based on some prior evidence and for the above reasons, the choroid of the albino rabbit was studied to learn whether a mast cell density gradient could be established. Several unique anatomical features exist in the rabbit eye. A density gradient that could be fitted to a simple exponential equation and that had several regions useful for statistical analysis, was demonstrated. Furthermore, it was reproducible and had a counting variance which was adequately constant for biological data. From birth to maturity, a similar gradient was present. A weight range (age) from just before maturity was selected as a control group for the assay of several agents (radiation and adrenocorticosteroids) that are thought to affect mast cells. Both radiation (gamma) and cortisone acetate were found to reduce the number of uveal mast cells by a statistically significant level, but they did not eliminate them even at unusually high dose levels. (auth)

4836 (NP–19046) EFFECTS OF ACUTE GAMMA RADIATION AND TEMPERATURE ON GROWTH AND SURVIVAL OF JUVENILE RAINBOW TROUT (SALMO GAIRDNERI). Edmundson, Eldon Hartzel Jr. (Washington State Univ., Pullman. Dept. of Zoology). 1971. 48p.

Thesis.

Effects of acute gamma radiation and temperature on survival and growth of juvenile rainbow trout (Salmo gairdneri) were studied in continuous flow aquaria utilizing a split-plot design. Fish fingerlings acclimated to 10°C were exposed to various doses of gamma radiation up to 1,000 R and placed into filtered tap water at 10°, 15°, or 20°C. They were raised in one of these water temperatures for 28 days and fed 4% of their body weight in commercial fish food once per day. Survivors were weighed weekly and counted daily in the basic experiment. There were no statistically significant ($P \leq .05$) effects of temperature, radiation, or temperature-radiation interaction on survival and growth. It was concluded that the combined action of acute gamma radiation less than 1,000 R and temperature regimes studied does not noticeably affect growth and survival of juvenile rainbow trout. (auth)

4837 (NVO–269–15) EFFECTS OF CHRONIC IRRADIATION BY TRITIATED WATER ON POECILIA RETICULATA, THE GUPPY. Erickson, Robert C. (Washington Univ., Seattle. Lab. of Radiation Ecology). 10 May 1971. Contract AT(26-1)-269. 27p. (CONF-710501–38). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Guppies were reared in tritiated water (HTO). The objectives were to characterize sublethal effects of chronic irradiation and to evaluate the effects of a range of HTO concentrations on the development and behavior of the guppy. Fish were exposed to HTO either throughout embryogenesis, average time 17 days, to concentrations of 0.025 to 0.50 mCi/ml, resulting in total doses of 90 to 2,500 rads, or at one week of age for periods of 21 to 30 days to concentrations of 0.05 to 1.0 mCi/ml, resulting in total doses of 350 to 4,700 rads. Significant effects were an increased proportion of males and an earlier appearance of male sex characteristics in fish exposed to the lowest HTO concentration used. At higher doses, courting intensity and rate of development of male characteristics were generally depressed. In irradiated male fish, both an increase and decrease in growth were seen; and those exposed to lethal heat stress showed both increased and decreased survival time, depending upon the dose. There were no effects seen on the survival of irradiated fish by 90 days following treatment. (auth)

4838 (RLO–2225–T–8–4) EFFECT OF X-IRRADIATION UNDER VARIOUS TEMPERATURE CONDITIONS AND EMBRYONIC DEVELOPMENTAL STAGES ON THE GROWTH AND MORTALITY OF CHINOOK SALMON. Wadley, Gerald Weldon (Washington Univ., Seattle). 1971. Contract AT(45-1)-2225. 121p. Dep. NTIS.

Thesis.

Embryonic stages of chinook salmon (Oncorhynchus tshawytscha) which included the one-cell, 32-cell, gastrula, epiboly, blastopore closure, and eyed, were exposed to acute, graded doses of x radiation. Prior to, during, and following irradiation the embryos were incubated at various temperatures and temperature regimes, i.e., fluctuating or constant, and reared just past the active feeding stage. Radiosensitivity of the embryos in terms of LD_{50} generally decreased with age but increases in temperature above ambient tended to decrease the LD_{50} of embryos independent of the developmental stage irradiated. Sublethal doses of x radiation significantly stimulated growth as measured by length and weight. Initiation of growth stimulation by x radiation did not appear to be temperature dependent but a temperature and radiation dose interaction significantly influenced the mechanism following initiation. This influence resulted, in general, in realization of growth stimulation from a lower radiation dose when administered at an elevated temperature than at a lower temperature. The mechanism responsible for growth stimulation, even though initiated by x radiation, appeared to be retarded by a constant temperature regime as compared to a temperature regime that followed the normal seasonal fluctuations. (auth)

4839 (RLO-2225-T-8-5) EFFECTS OF IRRADIATION AND TEMPERATURE ON YOUNG SALMONIDS. Final Report. Welander, Arthur D. (Washington Univ., Seattle. Lab. of Radiation Ecology). 29 Oct 1971. Contract AT(45-1)-2225. 16p. Dep. NTIS.

The effects of single doses of $^{90}Sr-^{90}Y$ β or x radiation ranging from 12 to 1,500 R delivered to chinook salmon (Oncorhynchus tshawytscha) embryos subsequently reared for four or five months in water temperatures ranging from 8.3 to 15.4°C were studied. There was no indication that mortalities in fish reared at 8.5 and 10.5°C were significantly increased by irradiation at doses as high as 427 R. Mortalities in fish reared at 14.0 and 15.4°C were so great that any irradiation effect was predominated by the temperature effect. Growth was not greatly affected by radiation doses as high as 1,148 R and doses up to 500 R stimulated growth in embryos subjected to irradiation at all developmental stages except blastopore closure. The relative biological effectiveness of β and x radiation was compared using the 133 day survival of

salmon embryos as the criterion. Rainbow trout, Salmo gairdneri, were reared for two years in water temperatures of 15.4 or 17.2°C following exposure to x radiation doses of 21, 83, or 203 R during the eyed embryo stage. No effect on survival, growth, or fecundity was observed. (C.H.)

4840 RELATIVE BIOLOGICAL EFFECTIVENESS OF 20 MeV ELECTRONS FOR RADIONECROSIS OF RABBIT BRAIN TISSUE. Smirnov, R. V.; Kurkovskii, V. P. (Leningrad Scientific-Research Neurosurgical Inst.). Dokl. Akad. Nauk SSSR; 198: No. 4, 954-5(1 Jun 1971). (In Russian).

The relative biological effectiveness (RBE) of an electron beam was compared with x radiation for induction of brain necrosis. A total of 17 rabbits were used as subjects: three were exposed to a single dose of x radiation and used as controls; seven rabbits were irradiated with single doses of 20 MeV electrons at a range of doses from 3,300 to 8,200 rad; and seven rabbits were irradiated three times per week with 400 rad to a total dose of 5,200 to 15,200 rad. The histological findings on the brains of the irradiated animals showed degeneration of nerve tissue and necrotic foci in some animals. Comparison of the smallest x ray dose (4,000 rad) causing a necrotic foci to that of the same electron dose, the RBE for single-exposure electrons was 0.64, and the RBE for fractionated dose electrons was 0.38. (K.S.W.)

4841 BLASTOGENIC RESPONSES OF HUMAN LYMPHOCYTES TO XENOGENEIC CELLS IN VITRO. Hersh, Evan M. (Univ. of Texas, Houston). Transplantation; 12: No. 4, 287-93 (Oct 1971).

The blastogenic responses of human lymphocytes to stimulation with irradiated xenogeneic cultured cells and xenogeneic lymphocytes were compared to responses to allogeneic cultured lymphoblasts and lymphocytes. Xenogeneic cultured cells stimulated vigorous blastogenesis as measured by either thymidine incorporation (median, 13,500 counts/min) or microscopic examination (median, 12% lymphoblasts). Maximum stimulation was induced by 5×10^4 xenogeneic cultured cells and levels of over 10^5 stimulator cells/culture inhibited blastogenesis. Xenogeneic lymphocytes induced a median maximum of 14,000 counts/min at a stimulator cell concentration of 10^6 cells/culture. Allogeneic cultured lymphoblasts and lymphocytes induced significantly greater blastogenic responses (median, 57,000 and 41,000 counts/min, respectively) but were also inhibitory at higher cell concentrations. Cultured cells, both allogeneic and xenogeneic, induced more uniform stimulation than small lymphocytes. These results indicate that humans have circulating antigen-reactive cells for murine cell surface antigens, that there are major quantitative differences in the characteristics of the stimulation produced by cells of different origin in terms of degree of stimulation and optimal stimulator cell level, and that irradiated cells release an inhibitor of blastogenesis. (auth)

4842 CHANGES IN THE MEGAKARYOCYTOPOIESIS IN MICE AFTER EXPOSURE TO IRRADIATION. Rudakov, I. A.; Tsygankova, V. A.; Rudakova, S. F.; Maslennikova, R. L. (Inst. of Medical Sciences, Obninsk, USSR). Stud. Biophys.; 26: No. 3, 199-206(1971).

While comparing the dynamics of megakaryocytes in the bone marrow of irradiated mice (CBA and BALB strains), it was established that the decrease of the total megakaryocyte number in the initial postirradiation period develops more slowly in comparison with the total nucleated bone marrow cell count. The normalization of the frequency of each megakaryocytic type comes before the full recovery of the total number of megakaryocytes. The restoration processes of the megakaryocyte compartment in radiosensitive mice (BALB strain) occur more slowly than in radioresistant mice (CBA strain). (auth)

4843 EFFECTS OF DOSE FRACTIONATION ON POPULATIONS OF MAMMALIAN CELLS. Silini, G. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 125-40(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967)

In the radiobiological response of an irradiated cell population it is possible to distinguish operationally three phases: damage, repair, and repopulation. It may be presumed that repeated dose fractions act by way of analogous phases following each fraction. Information on the final effect of such events under a fractionation regime may be derived from a knowledge of the number of cells and of their radiosensitivity at any given time. The experiments of Elkind and Sinclair have represented for some years a point of reference in the analysis of these phenomena. They have shown that cells surviving a dose of radiation undergo repair of sublethal damage following peculiar kinetic patterns and have provided a cellular basis for the interpretation of the recuperation phenomena under conditions of dose fractionation. The practical importance of these observations is mainly evident under two conditions; irradiation of neoplastic cells and whole-body irradiation of animals with fractionated doses. The object of the present paper is to illustrate some aspects of radiobiological work referring to both these conditions. The first series of data is concerned with an analysis of repair in a transplantable lymphatic tumor of the mouse, irradiated and tested entirely in vivo. By the use of the spleen colony assay we have established the kinetic characteristics and the time limits of sublethal damage repair in these cells. We have also shown some peculiarities of the system as compared to other in vitro cell systems. The second series of data concerns the radiosensitivity and repair of bone-marrow stem cells that are considered the primary target for the bone-marrow failure following irradiation. Similarities were shown between the time course of repair of stem-cells and the decay of whole-body damage, measured as $LD_{50/30}$. In this system, changes in D_0 and in the extrapolation number of the stem-cell survival curves contribute to the final effect. These as well as other data provide useful schemes of interpretation of clinical observations and are discussed for their implications in radiotherapy. (auth)

4844 RESPONSE OF THE ANIMAL TO WHOLE-BODY FRACTIONATED IRRADIATION. Metalli, P. (CNEN, Rome). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 141-92(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967)

The technique of whole-body fractionated irradiation allows the collection of basic data that are of interest to both radiation protection and the study of recuperation phenomena from radiation damage in the entire organism. The author underlines certain aspects which make the study of whole animals more difficult with respect to simple biological materials, and describes the usual methods of whole-body irradiation with fractionated doses. The principal fields of study are then reviewed in which the dose-fractionation techniques have most greatly contributed to a better understanding of the repair events in the mammal. Data from the reviewed references were classified into two groups, corresponding to two successive periods of research. Prevailing formal interpretations of the recuperation phenomena were considered in the first period: the exponential kinetics of recovery and the formal definition of irreparable damage, in connection with the problems of life-span shortening by radiation and with the so-called acquired radioresistance. The research carried out in the second period and up to date, yielded results that have substantially modified the general conclusions arrived at previously, allowing a first attempt at the interpretation of repair events on a cellular basis. After a brief summary of the most recent data on the radiation biology of isolated cells, experiments are reported that have greatly contributed to the definition of both short and long term recuperation kinetics after whole-body irradiation. From these experiments it would appear that the concept of simple exponential decline of the radiation damage should be abandoned, because the recuperation at the whole-body level seems to be an extremely complex phenomenon, due to the sum of at least three components: rapid events of intracellular repair, possible synchronization of the mitotic cycle of surviving cells, and repopulation by cell proliferation. Finally, recent models are discussed that attempt to define the concept of irreparable damage on a cellular basis in connection with the mechanisms responsible for the life-span shortening and other late effects. (auth)

4845 COMBINED EFFECTS OF X IRRADIATION AND NO_2 GAS EXPOSURE ON RES. PART II. Mori, K.; Nakamura; Seiichi; Andoh, Tsuyoshi; Miura, Takeo. Taiki Osen Kenkyu; 5: No. 1, 147(1970). (In Japanese).

The effect of exposure to nitrogen dioxide gas on the physiology of the reticuloendothelial system was studied in mice. Attention was given to aggregate capacity, speed of foreign body elimination, and the rate of phogocytosis. There were no effects of NO2 exposure on the aggregate capacity or the speed of foreign body removal, but for a mouse whose resistance had weakened due to x irradiation, functional degeneration due to NO2 exposure was seen. (Air Pollution Abstr.)

4846 FEED EFFICIENCY IN SWINE FOLLOWING PATERNAL X-IRRADIATION. Mullaney, P. D.; Cox, D. F. (Ames Lab., Iowa). Mutat. Res.; 11: No. 3, 350-2(Mar 1971).

An important quantitative trait in swine is the efficient utilization of feed for liveweight gain, since at least 70% of the cost of producing a market-weight pig is for feed. Feed efficiency may be variously defined, however gross efficiency, the ratio of liveweight gain to feed consumption, is probably of most practical importance to pig producers. Results are reported from a study on the effects of paternal x irradiation on the gross feed efficiency of Duroc and

Hampshire litters. One male of each pair was exposed to 300 R of x radiation directed to the center of the testes at approximately 100 R per min; the other male of the pair was not so exposed. Each pair of males was mated to approximately 5 to 7 pairs of full sisters. Young pigs were weaned at 42 days of age, by removal of the sow from the pen. One hundred pounds of grower ration (16% protein) were allowed each pig after weaning. Pigs were then fed ad libitum a fattening ration (14% protein) until 154 days of age. Feed records were available only for the litter, and hence the litter mean was the unit of measurement. Gross feed efficiency was measured as the ratio of liveweight gain between 42 and 154 days of age to feed consumed during the same period. (C.H.)

4847 RADIATION EFFECT ON THE VASCULARIZATION OF A C3H MOUSE MAMMARY CARCINOMA. MICROANGIOGRAPHIC STUDIES OF THE TUMOR IN PREIRRADIATED TISSUE AND OF THE RECURRENT TUMOR. Saeki, Yuji; Shimazaki, Shozo; Urano, Muneyasu (Kyoto Prefectural Univ.). Radiology; 101: No. 1, 175-80(Oct 1971).

The effects of x radiation on blood vessels structure were studied in C3H mouse mammary carcinomas. Vascularization of nontreated tumors, of recurrent tumors, and of tumors transplanted into a previously x irradiated tumor bed was examined microangiographically. In the nontreated tumor, vascularization was peripheral with penetrating vessels. Vasculature of recurrent tumors and tumors in the preirradiated tumor bed was basically the same. Rich vascularization was located only in the periphery where abundant fine vessels branched, but never stretched into the tumor center. (auth)

4848 EFFECT OF FRACTIONATION OF RADIATION DOSE ON CALLUS FORMATION AT SITE OF FRACTURE. Hayashi, Shigejiro; Suit, Herman D. (Univ. of Texas, Houston). Radiology; 101: No. 1, 181-6(Oct 1971).

The effect of γ radiation on callus formation was studied in mice whose femora had been fractured after irradiation of the leg and thigh. The end point was the CID_{50}, or dose which produced a specified inhibition of callus formation in half of the subjects. CID_{50} was 1,750 rads, 2,270 rads, 3,020 rads, and 3,600 rads for radiation given in 1-, 2-, 5-, or 10-dose fractions. The CID_{50} was 2,270, 2,420, and 2,470 rads for time intervals between dose 1 (1,000 rads) and dose 2 on one, seven, and twenty-eight days respectively. (auth)

4849 VOPROSY EKSPERIMENTAL'NOI I KLINICHESKOI RADIOLOGII. VYPUSK IV. (Problems in Experimental and Clinical Radiobiology. Number 4). Shantyr, V. I. (ed.). Kiev; Zdorov'ya (1968). 204p.

Forty-six papers by different authors discuss a wide variety of experimental investigations and clinical observations in radiobiology, and encompass different types of radiation, including 3.5 MeV electrons, 35 MeV electrons, and x radiation. Tracer studies using radioisotopes such as ^{32}P, ^{45}Ca, ^{59}Fe, and ^{131}I are considered. Biochemical changes studied in irradiated animals include nucleic acid content, blood protein changes, and effects on content of thrombocytes and 17-ketosterols. Several papers focus attention on various aspects of radiation sickness. (K.S.W.)

4850 SOME REGULARITIES OF THE CHANGE OF THE LYMPHOCYTE COUNT IN THE PERIPHERAL BLOOD AND IN THE BONE-MARROW OF RATS IN THE EARLY STAGE OF RADIATION SICKNESS. Gruzdev, G. P.; Shcherbova, E. N. Radiobiol.-Radiother.; 12: No. 2, 251-5(1971). (In German).

The examinations were performed with rats being exposed to a uniform or non-uniform x irradiation. It was shown that the speed of regeneration of the lymphocyte count in the peripheral blood of rats increases exponentially between the 2nd and the 4th day of radiation sickness with the increase of the radiation dose from 25 to 300 R. The duplication of the regenerative speed is achieved by about 200 R. The permanent correlation of the lymphocyte content in the peripheral blood and in the bone-marrow of non-uniformly irradiated animals has to be emphasized which gives evidence of a permanent migration of the lymphocytes from the peripheral blood into the bone-marrow damaged by a high dose. The intensity of migration is proportional to the lymphocyte count in the blood of the animals. (auth)

4851 PREDICTION OF INDIVIDUAL DIFFERENCES IN RADIATION TOLERANCE OF RATS AND THEIR MODIFICATION BY SEASONAL INFLUENCES. I. EFFECT OF SEASON ON THE DISTRIBUTION OF SELECTION TEST VALUES. Pospisil, M.; Zakopalova, I.; Filip, J. (Inst. of Biophysics, Brno). Stud. Biophys.; 27: No. 2, 119-24(1971).

Irradiated rats were placed individually in glass cages for five days and the Na/K ratio was determined in 24 hr samples of urine; experiments were conducted at all seasons of the year. Results are given in the form of graphs for percentage distribution of Na/K values in groups of animals born in the spring-summer period and in the autumn-winter period and percentage distribution of Na/K values in groups of animals irradiated in the spring-summer period and in the autumn-winter period. It was found that higher values were obtained for animals born in the spring and summer but values were not affected by the season in which the experiment was carried out. (H.L.W.)

4852 PREDICTION OF INDIVIDUAL DIFFERENCES IN RADIATION TOLERANCE OF RATS AND THEIR MODIFICATION BY SEASONAL INFLUENCES. II. EFFECT OF SEASON ON PROGNOSTIC EFFICACY OF THE SELECTION TEST. Pospisil, M.; Zakopalova, I.; Filip, J. (Inst. of Biophysics, Brno). Stud. Biophys.; 27: No. 2, 125-30(1971).

The effects of seasonal influences on the prognostic efficacy of the previously described test of reactivity, permitting the preirradiation prediction of interindividual differences in radiation tolerance of rats were analyzed. It was found that the prognostic efficacy of the test plays a most outstanding role in experiments carried out in spring and summer months. (auth)

4853 CHANGES IN THE MOUSE ELECTROCORTICOGRAMS (ECoG) AFTER X-IRRADIATION. Minamisawa, Takeru; Sugiyama, Hiroshi; Tsuchiya, Takehiko; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 12: No. 1, 7-16(Mar 1971).

The effects of x-rays on the electrocorticograms (ECoG) of mice which had received 300 R of x-rays to the head were studied. The ECoG were recorded in half-restrained animals with chronically implanted cortical electrodes, and were stored on FM magnetic tape. The ECoG recordings were classified into 7 frequency bands by means of an EEG frequency analyzer, and the amplitude of each wave was measured. After x-irradiation the percentage of the waking pattern in the ECoG decreased and reached a minimum 2 to 5 hours after exposure. This was followed by a gradual increase, and a return to control level on the 5th day. Bursts which were composed of 2-4 sec trains of 9-11 c/sec occurred more frequently after exposure. The amplitude of δ_2, δ_1, θ and α waves was above control level for 5 days after irradiation. The implications of the effects of x-rays on the mouse ECoG are discussed. (auth)

4854 RADIOSENSITIVITY OF THE BONE-FORMING PROCESS OF HETEROTOPICALLY-GRAFTED RAT BONE-MARROW. Amsel, Sheldon; Dell, Elisabeth S. (Veterans Administration Hospital, Boston). Int. J. Radiat. Biol.; 20: No. 2, 119-27(1971).

Haemopoietic tissue when grafted to a heterotopic site has bone-forming potential. The incidence of bone formation by subcutaneously-placed rat marrow was plotted as a function of the number of cells in the transplant. 48×10^6 nucleated marrow cells were then exposed in vitro to varying doses of x-radiation, transplanted subcutaneously, and the incidence of bone formation observed. By using the original curve, it was possible to determine the fraction of cells surviving radiation. A dose-survival curve was constructed which was exponential, and from the linear part a D_0 of 235 rads with an extrapolation number of 1·2 was calculated. The significance of the relative radioresistance of the bone-forming process when compared to the radiosensitivity of the haemopoietic function of bone-marrow was discussed. (UK)

4855 MORPHOLOGIC AND FUNCTIONAL STUDIES ON RAT PAROTID GLAND FOLLOWING SUBLETHAL X IRRADIATION. Leifer, Calvin. Buffalo; State Univ. of New York (1971). 249p. University Microfilms Order No. 71-22,575.

Thesis.

Male Sprague-Dawley rats, 7 to 9 weeks of age, were x-irradiated with a single dose of 1000 R to the left head and neck regions. The animals were randomly grouped and sacrificed at 3, 6, 12 and 24 hours, 3 days, 1 and 2 weeks post-irradiation. The treated glands were excised and processed for light and ultrastructural morphology and for acid phosphatase cytochemistry with light and electron microscopy. A sham-treated and an untreated group served as controls. Ultrastructurally, the study revealed sequential morphologic alterations in the parotid acinar cells. Changes were undetected by light microscopy. At 3-6 hours post-irradiation, focal areas of cytoplasm were screened off by membranes, partly of RER origin thus forming an early autophagic vacuole. Light microscopic cytochemistry for acid phosphatase, using the coupling of pararosaniline and naphthol AS-TR, demonstrated occasional reaction centers in the acinar cells and a moderately positive reaction in intercalated and striated duct cells of the untreated animals. The intensity of the reaction within the acinar cells continued to increase until it reached its peak at 24 hours post-irradiation. The reaction

product was predominately perinuclear and almost exclusively limited in the basal portion of the cell. Other groups of experimental animals were locally x-irradiated with 1000 R, 2½ hours following isoproterenol. They were sacrificed at various time intervals following x-irradiation. The control animals were sacrificed at the corresponding time intervals and included a group of untreated fasted rats, another of sham-treated rats, still another received only isoproterenol, and lastly a group which was treated with x-irradiation only. Reaccumulation of α-amylase following almost total depletion was studied in the whole homogenate and in various cell fractions prepared by differential centrifugation. Alpha-amylase activity was assayed by using RBB-starch which was proven more reliable than reductimetry in the preliminary studies. Reaccumulation in all depleted parotid glands showed an initial time lag of 6 hours. The controls treated only with isoproterenol showed an almost exponential increase in α-amylase from 6 to 10 hours followed by a constant rate of reaccumulation. At 22 hours, the glands contained α-amylase equal to 65% of their fasted levels. A similar pattern was noted in the sham-treated animals. In the experimental group α-amylase activity increased linearly from 6 to 10 hours but reached values similar to those of the control groups at 22 hours. The rate of reaccumulation in the zymogen and microsomal fractions generally paralleled those of the homogenates. Comparison of the results of recovery studies in x-irradiated and non-irradiated groups indicated the possible presence of an α-amylase inhibitor in the x-irradiated parotid glands. (Diss. Abstr.)

4856 CYTOMORPHOLOGICAL ANALYSIS OF ULTRASTRUCTURAL ALTERATIONS IN THE CEREBELLUM OF THE RAT IMMEDIATELY FOLLOWING ACUTE WHOLE-BODY GAMMA IRRADIATION. Elissalde, Marcel Howell Jr. College Station, Tex.; Texas A and M Univ. (1971). 246p. University Microfilms Order No. 71-24,663.

Thesis.

Twenty-five sexually mature albino rats were divided into equal size groups. Each group received one of the following treatments: no irradiation, 1,000 rad, 2,000 rad, 5,000 rad, or 10,000 rad. The whole-body gamma radiation was delivered at 413 rads per minute. The cerebellar cortex was fixed by immersion or glutaraldehyde fixation 30 minutes postirradiation for electron microscopic observation. Measurements taken from electronphotomicrographs of the organelles of the granule cells, stellate nerrons, astrocytes, Bergmann glia, oligodendrocytes, microglia, and Purkinje neurons were statistically analyzed. In comparisons within and between non-irradiated animals no significant differences were found to occur between organelles of specific cell types. Comparisons made within the same dosage groups showed a significant difference between the Bergmann astrocyte granular endoplasmic reticulum intramembranous spaces and between the oligodendrocyte myelin periodicity of the 10,000 rad groups at the .05 level. Comparisons were finally made between the organelles of specific cell types of the control and irradiated groups. The following statements summarize the results of these comparisons. The nuclear membrane diameter, nuclear membrane thickness, nuclear membrane pore diameter and nuclear membrane pore separation in all cell types were not significantly affected by radiation at any level. (Diss. Abstr.)

4857 EFFECT OF PENETRATING RADIATION AND HISTONES ON ACTIVITY OF SUCCINATE DEHYDROGENASE AND OPTICAL DENSITY OF RAT LIVER MITOCHONDRIA. Dovgii, I. E.; Minaev, P. F.; Vilinskaya, V. S. (Inst. of Biophysics, Pushchino, USSR). Ukr. Biokhim. Zh.; 43: No. 4, 471-4(Jul-Sep 1971). (In Russian).

The activity of succinate dehydrogenase and the optical density of rat liver mitochondria were determined at different times (2 hrs, one, three, and seven days) after total x irradiation (400 R) and under the effect of total histones. A decrease is established in the succinate dehydrogenase activity at all the times of investigation, excluding the first day when an insignificant enzyme activation occurs. The total histones inhibit the activity of succinate dehydrogenase. The optical density of liver mitochondria of the irradiated animals is lower than that of the non-irradiated ones. Histones as well as radiation evoke swelling of mitochondria. Probably, both factors affect the structure of mitochondria, which involves changes in the activity of succinate dehydrogenase. (auth)

4858 RADIATION RESPONSE OF THE PREIMPLANTATION MOUSE EMBRYO IN VITRO. Kirkpatrick, Jay Franklin. Ithaca, N. Y.; Cornell Univ. (1971). 129p. University Microfilms Order No. 71-22,982.

Thesis.

A technique was established for in vitro culture of preimplantation mouse embryos, and their development under these conditions was characterized. The embryos were recovered from superovulated mice, cultured and x-irradiated at various stages of development. Preimplantation embryos were also irradiated and grown in vivo. The investigations included a study of the effects of superovulation on preimplantation embryos, a comparison of the effects of radiation delivered to embryos in vivo and in vitro, a measurement of differential sensitivity of various stages of development, a description of the morphologic abnormalities produced by radiation and a measurement of radiation induced cleavage delay. Superovulation was induced by an injection of pregnant mares'serum (PMS) followed 44 hours later by chorionic gonadotropin (CG). Ovulation occurred 7-8 hours after the CG injection. The following LD_{50} values (based on development to the blastula) were determined for embryos irradiated in vitro: 390 rads, two-cell stage; 570 rads, four-cell stage; 325 rads, morula stage. In addition, one-cell embryos were irradiated in vivo at either 3.5 or 13.5 hours after coitus, removed at the two-cell stage and cultured. The LD_{50} values for these embryos were 175 rads (3.5 hours) and 255 rads (13.5 hours). The LD_{50} values for embryos irradiated and grown in vivo were: 150 rads, one-cell (3.5 hours after coitus); 200 rads, one-cell (13.5 hours after coitus); 420 rads, two-cell; 640 rads, four-cell and 340 rads, morula stage. It can be seen from these values that this response to radiation was similar in embryos irradiated in vivo and in vitro. The LD_{50} values were higher than those previously reported. This may be the result of manipulation of the data, which was done to account for embryo loss as a result of factors not related to irradiation. Fragmentation and disintegration were the most common abnormalities produced by radiation doses in the range of 200 to 600 rads. Incomplete cleavage, cytoplasmic granulation and cleavage cessation were also seen. Embryo mortality could be directly correlated with the appearance of these abnormalities. Radiation also resulted in cleavage delay of 2.8 hours after 300 rads, and shorter times for lower doses. It was concluded, that with certain limitations, the in vitro culture system was a very useful and appropriate technique for radiation studies of early embryos. (Diss. Abstr.)

4859 INDUCTION OF LIVER ENZYMES BY CORTISOL AFTER COMBINED TREATMENT OF MICE WITH X IRRADIATION AND INHIBITORS OF PROTEIN BIOSYNTHESIS. Streffer, Christian; Schafferus, Sigrid (Univ., Freiburg i. B.). Int. J. Radiat. Biol.; 20: No. 4, 301-13(1971).

The induction of hepatic tryptophan pyrrolase and tyrosine aminotransferase by cortisol was measured in mouse liver. After a whole-body x irradiation with doses higher than 2000 R given 2 to 3 min after the injection of the steroid, the biosynthesis of the tryptophan pyrrolase was decreased, but that of the tyrosine aminotransferase unchanged. In further experiments, the irradiation was combined with actinomycin D, puromycin, and ethionine. These inhibitors of protein synthesis were administered in doses that themselves had no influence on the inductive process of these enzymes. When actinomycin D was simultaneously given with the irradiation, the hormonal induction was enormously reduced. Ethionine did not modify the radiation effects, whereas puromycin potentiated the effect on the tryptophan pyrrolase markedly and had only a small influence on the tyrosine aminotransferase activity. The mechanism of the observed changes is discussed. It is suggested that specific effects at the translational level of protein biosynthesis contribute to the radiation-induced disturbances. (auth)

4860 EXAMINATION OF PHOSPHATE EXCRETION OF RATS FOR THE DETECTION OF RECOVERY PROCESSES AFTER IRRADIATION. Becker, H. D.; Krzonkalla, H. (Humboldt Univ., Berlin). Radiobiol.-Radiother.; 12: No. 3, 371-6 (1971). (In German).

Recovery processes were examined with irradiated rats by means of the excretory dynamics of inorganic phosphate. According to that, excretory analyses after the second irradiation seem to be suited for substances showing early and short-time changes after one irradiation for the further processing of the problems of recovery. After whole body irradiation with 300 R, a recovery of those biological events that participate in the phosphate excretion increased after irradiation was observed after 4 days. After several fractions, the courses of damage and recovery are obviously disturbed by radiation-induced mechanisms having a longer time of reaction. (auth)

4861 PROLIFERATIVE ACTIVITY OF THE BLOOD-FORMING TISSUES UNDER THE CONDITIONS OF EXPERIMENTAL CHRONIC GAMMA-RAY IRRADIATION. Belousova, O. I.; Fedotova, M. I. Radiobiol.-Radiother.; 12: No. 2, 243-50 (1971). (In German).

In experiments with guinea pigs being exposed to chronic gamma irradiation in doses of 10 R/d five times a week with a

dose rate of 0.5 to 0.7 R/h to a total dose of 1850 to 2000 R, the reactions of the blood-forming organs were studied by means of quantitative methods of assessment. Considerable disturbances were observed in the myeloid germ of the bone marrow. At the same time with the suppression of the proliferative activity of the early myeloid cell generations, a decrease of the transformation of the reticular cells was found. The present disturbance is not evident in the erythroid germ. The absolute count of lymphoid cells in the spleen, in the femoral bone-marrow, and in the peripheral blood of guinea pigs after total doses of 600, 800, 1000, 1600, and 1850 to 2000 R does not differ from the controls. In four animals, an acute leucosis-reticulosis was observed. (auth)

Man

Refer also to abstracts 4731, 4732, 4754, 4758, 4763, and 4770.

4862 (ABCC-59-71) ABCC TECHNICAL REPORTS, 1959-71. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 157p. Dep. NTIS.

Technical reports issued by the Atomic Bomb Casualty Commission (ABCC) are listed according to date, author, and subject key word. A fourth list contains references to technical reports issued under the collaborative JNIH-ABCC protocols. These reports are listed in chronological order. (E.R.B.)

4863 (ABCC-70-71) ATOMIC BOMB CASUALTY COMMISSION ANNUAL REPORT, JULY 1, 1970-JUNE 30, 1971. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 335p. (In Japanese and English). Dep. NTIS.

Brief outlines are presented for a total of 78 studies conducted during the period covered by this report to evaluate the effects of radiation exposures received by residents of Hiroshima and Nagasaki during the atomic bombings 25 years previously on the health of individuals and their offspring. A list of 43 technical reports and 360 journal publications during the period is included. (C.H.)

4864 (AECL-4052, pp 19-23) POPULATION RESEARCH. Newcombe, Howard B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 1971.

In Biology and Health Physics Division progress report.

Studies on hereditary changes in vertebrates included low-dose radiation effects in fish embryos from irradiated sperm and studies on chromosome cytology in cell cultures from embryos. The following methods for the study of somatic and genetic harm in human populations are described: development of linked files of British Columbia vital and health records; ascertainment of congenital anomalies through British Columbia hospital insurance records; and examination of data from tuberculosis patients with cancer following repeated exposure to x radiation during fluoroscopy. (H.L.W.)

4865 (FRNC-TH-82) ATTEMPT TO SYNTHETIZE THE AVAILABLE INFORMATION ON THE EVOLUTION OF INDUCED HEMATOLOGICAL ANOMALIES RESULTING FROM AN ACUTE RADIATION ACCIDENT. Duraffourd, Christian (Paris Univ. (France). Faculte de Medecine). 1970. 59p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Myeloproliferative hematologic anomalies observed in man following acute radiation exposures are described. The time required for the hematologic anomalies to appear was very much less than that observed for other acute injuries. The anomalies observed in bone marrow samples were particularly disturbing in regard to their evolutionary character and the differences observed between consecutive examinations. A high level of histamine was observed which increased between successive examinations. This finding is characteristic of the myeloproliferative syndrome. (France)

4866 (PEL-209) LUNG CANCER AND EXPOSURE TO RADON DAUGHTERS IN SOUTH AFRICAN GOLD/URANIUM MINES. Basson, F. K.; Wyndham, C. H.; Keeley, W. H.; Barnard, C. P. S.; Munro, A. H.; Webster, I. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Mar 1971. 17p. INIS.

An increased incidence of lung cancer among miners in overseas uranium-bearing mines is being ascribed to exposure to high concentrations of radon and its decay products. The consequences of such prolonged exposure to a relatively low radiation rate are of basic importance to the International Commission on Radiological Protection (ICRP). They also serve as a basis for the so-called Working Level (WL) allowed by norm in the North American uranium mines. South Africa has a large and relatively stable mining population, working, under excellent medical surveillance, in gold/uranium mines with radon concentrations of less than 1 WL and in which conditions have not changed materially in the last 50 years. It has thus been evident for some time that a study of the incidence of lung cancer among South African miners could perhaps furnish unique information on the effect of relatively low radiation levels. A study was undertaken to determine whether, as a result of exposure to radon daughters arising from the presence in the ore, as mined, of low concentrations (0.015 to 0.075 per cent U_3O_8) of uranium, the incidence of lung cancer among South African gold miners is greater than it is in the male population as a whole. A random sample of 1100 men was drawn from the total of 227,000 white miners registered by the Chamber of Mines up to the end of 1967, and the cumulative exposure for each man was calculated as the product of the shifts worked underground and the relevant concentration of radon daughters. On the basis of surveys made in twelve typical mines, estimates of radon concentrations expressed in Working Levels were assigned to each of the 119 mines concerned. The average cumulative exposure over the period 1960 to 1971 was 35.8 Working Level months. From the number of deaths due to bronchogenic carcinoma and the estimated population at risk (using an expansion factor 227 000/1100 = 206), the crude death rates per 10,000 miners per year were calculated for the eight-year period. The average annual death rate due to lung cancer among white gold miners in South Africa was found to be 2.96 per 10,000 as compared with the 3.12 for the general population of white South African males. It is concluded that the death rate from lung cancer among white South African miners has not been increased by radon exposure. This is to be expected as the average exposure of the South African miner is very low indeed and cannot be compared with the exposures occurring elsewhere in mines with high concentrations. Furthermore, although this investigation was undertaken as a pilot study, it appears that no improved results would be obtained by increasing the sample size as the estimates of cumulative exposure of individuals are necessarily very crude and the spread of exposures very narrow. (INIS)

4867 (UCSF-10-P-2-143) XERODERMA PIGMENTOSUM: PROGRESS AND REGRESS. Cleaver, James E. (California Univ., San Francisco. Lab. of Radiobiology). [1971]. Contract AT(11-1)-Gen-10. 19p. Dep. NTIS.

Xeroderma pigmentosum (XP) is an autosomal recessive human skin disease in which the outstanding clinical symptom is a high level of actinic carcinogenesis. The most common form of XP has a reduced capacity for excision repair of UV damage to DNA: the site of the defect is at the initial stage of the repair pathway. XP cells are precisely analogous to bacterial strains UVR^-, HCR^- Two minor variants of the disease are known with similar skin symptoms. One has the same defect in excision repair (possibly a deletion since excision repair is completely absent in several cases) and additional severe neurological symptoms. The other apparently has normal excision repair and normal UV sensitivity in vitro. From considerations of resolution and our experience in one test case, prenatal diagnosis of XP is practicable and autoradiography (unscheduled synthesis) is the most reliable and sensitive method to use, though several other methods are also applicable. Carcinogenesis in XP may conceivably develop through the unrepaired damage in DNA which leads to genetic changes (mutations, chromosome aberrations) or viral transformation. (45 references.) (auth)

4868 IRRADIATED PVC PLASTIC AND GAS STERILIZATION IN THE PRODUCTION OF TRACHEAL STENOSIS FOLLOWING TRACHEOSTOMY. Lipton, Barbara; Gutierrez, Rosa; Blaugrund, Stanley; Litwak, Robert S.; Rendell-Baker, Leslie (Mount Sinai School of Medicine, New York). Anesth. Analg. (Cleveland); 50: No. 4, 578-86(Jul-Aug 1971).

During 1967 and 1968, five patients on the cardiac surgical service developed tracheal stenosis following tracheostomy in which a polyvinyl chloride (PVC) cuffed tracheostomy tube was used. Prior to 1967, at which time the use of the PVC tube began, no cases of tracheal stenosis subsequent to tracheostomy were reported. In all five of the cases reported, the PVC tubes had been sterilized with γ rays by the manufacturer and subsequently resterilized with ethylene oxide (ETO) at the hospital if previously opened but not used. Although mechanical irritation was involved, chemical irritation of the tissue was postulated to be the primary factor in the development of tracheal damage severe enough to produce subsequent tracheal stenosis. The chemical irritants that were postulated were ETO alone, ethylene glycol produced by the interaction of moisture with ETO, and ethylene chlorohydrin produced by the reaction of ETO with chloride ions released from PVC by γ irradiation. Gas chromatographic analysis of PVC tubes that were γ-irradiated and subsequently treated with ETO confirmed the presence of these irritants in the tubes. (E.R.B.)

4869 CONSIDERATIONS ON SOME COMPLICATIONS CORRELATED WITH RADIOTHERAPY OF CUTANEOUS ANGIOMAS.

Francesconi, G.; Fenili, O. (Ospedale Generale Provinciale, Lucca, Italy). Boll. Mal. Orecchio, Gola Naso; 88: 215-34 (1970). (In Italian).

Radioinduced injuries following radiotherapy of cutaneous angiomas are discussed. Data on 17 cases are reviewed that emphasize the fact that, although truly brillant results are initially obtained by radiotherapy, they may be followed by alterations manifesting their gravity after years or even decades. (auth)

4870 LATERO-CERVICAL RETICULOSARCOMATOSIS AFTER TONSILLECTOMY WITH ACUTE LEUKEMIC SYNDROME APPEARING DURING RADIOTHERAPY. Maroncelli, Marcello (Univ., Rome). Clin. Otorinolaringoiat.; 20: No. 6, 513-23(Nov-Dec 1968). (In Italian).

Literature on the importance of radiations as ethiological agents in the induction of leukemia is reviewed. A case in which, after an interval of two months following tonsillectomy, a picture of laterocervical and mediastinic sarcoma appeared, followed by the syndrome of acute leukemia during the course of radiotherapy. The greater seriousness of radio induced leukosis as compared with spontaneous leukemia, and the difficulty of knowing the threshold dose of x rays for the complex of specific individual biological reactions that result in leukemia induction are discussed. (TSS)

4871 GROWTH OF TUMORS IN MAN IN RELATION TO RADIOTHERAPY. Bresciani, F. (Univ., Messina, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 53-78(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

An analysis of neoplastic growth in man shows that in all tumors investigated, with the exception of Burkitt's lymphosarcoma, only a fraction of the cell population proliferates; in most cases the non-dividing fraction of cells appears to be much larger than the growth fraction, up to 96% in some mammary tumors. It is shown that another major factor of neoplastic growth is cell loss, which in some intestinal tumors is sufficiently high to balance cell production. This analysis of neoplastic growth in man is supported by experiments carried out with two mammary tumors of C3H mice, one of which shows a fast and the other a slow growth rate. As in many normal tissues, an aliquot part of the non-replicating cell fraction is most likely able to recommence division, for instance in emergency conditions like destruction of a large portion of the tumor. In conclusion a picture of tumors emerges consisting of at least three sub-populations in variable proportion: a first one of proliferating cells (p-cells), a second one of cells at proliferative rest but potentially clonogenic (G_0-cells) and a third one, of cells that have irreversibly lost the ability to replicate (z-cells). If one makes the reasonable assumption that the three sub-populations are differently radiosensitive, the variable proportion in which they are present in tumors furnishes an explanation for the maximal radiosensitivity of cell cultures in vitro — in which all cells are dividing — with respect to tumors in vivo, and for differences between tumors. This hypothesis also explains the positive correlation between radiosensitivity of a tumor and its growth rate, because growth rate is shown to be correlate with Ip, the cell-fraction in proliferative activity the most radiosensitive of the three cell-sub-populations. (auth)

4872 LIMITS AND APPLICABILITY OF METHODS OF FRACTIONATION OF THE DOSE IN RADIOTHERAPY WITH HIGH ENERGY AND ELECTRONS. Piemonte, M. (Spedali Civili, Brescia, Italy). Med. Nucl.-Radiobiol. Lat.; Suppl. No. 2, 237-53(1967). (In Italian).

From first symposium of National Association of Italian Medical Radiobiology; Rome, Italy (30 Sep 1967).

The administration to the neoplastic volume of a determined focus-dose is given for recovery following radiological therapy of a neoplasm. Administration of a determined dose-volume depends on the quality and energy of the radiations used, volume of the irradiated tissues, irradiation technique, and the dimensions of the irradiated region of the patients body. The total focus-dose and the integral dose are administered according to varying fractionations, conditioning different biological responses of the irradiated tissues. Leaving aside therapeutic results of the total focus-dose and integral dose, the author examines cutaneous, subcutaneous, focal, perifocal, and general reactions following the fractions used presently in radiobiological treatment of neoplasms of various place and type at the O. Alberti Radio Institute of the Brescia Civil Hospitals. The examination includes evaluation of immediate, delayed, and extremely protracted reactions, (and, for each of these, the acute, subacute, or chronic characteristics) following irradiation with static and kinetic methods, using sources respectively of ^{137}Cs, ^{60}Co, electrons of various energies, and x rays up to 18 MeV on a Siemens Betatron. (auth)

4873 RADIATION INDUCED CANCER OF LARYNX AND PHARYNX. Cronin, J. (Manchester Royal Infirmary, Eng.). J. Laryngol. Otol.; 85: 621-2(Jun 1971).

A case report is presented of a male patient with two primary carcinomata, one in the larynx and the other in the hypopharynx. He had received x radiation therapy of the neck over a 12-month period for the treatment of hyperthyroidism 30 years previously. This case was considered to be one of radiation induced cancer. (C.H.)

4874 RADIATION RISKS FROM RADIODIAGNOSTIC PROCEDURES. Drug Ther. Bull.; 8: No. 22, 85-8(23 Oct 1970).

With most diagnostic radiographic and radioisotope procedures the likelihood of inducing malignancy is very small, but with therapeutic techniques using high doses, and in the fetus, the risk is greater. In all cases the risk needs to be weighed against the diagnostic advantages, which deserve more explicit assessment than they often get. (auth)

4875 IMMUNE RELATIONS OF HYPOTHYROIDISM AFTER RADIOIODINE THERAPY. Torgyan, S. (Hauptstaedtische Bezirkskrankenhauses, Budapest). Radiobiol.-Radiother.; 12: No. 2, 209-17(1971). (In German).

Immune serological controls were made of 74 patients with hyperthyreosis who were treated with radioiodine before and 3 and 6 months, respectively, after therapy. The obtained results are compared with those of the detailed clinical examinations of thyroid function tests and of control cases. A connection between the antibody level after irradiation and the thyroid function tests first of all with respect to the formation of the level of protein iodine could be found. The so-called early hypothyroidism that developed after radioiodine therapy in antibody positive patients with hyperthyreosis is verified by some cases. Data in literature with regard to the therapy to be followed, completed by our own experiences, are summarized. (auth)

4876 RADIATION INDUCED PROGRESSIVE BONE DYSTROPHY. PRELIMINARY COMMUNICATION. Zomer-Drozda, Jadwiga (Oncological Inst., Warsaw). Radiobiol.-Radiother.; 12: No. 3, 297-304(1971).

The character of radiation induced bone lesions is discussed and possibility of changes stabilized over many years or having a progressive character is indicated. Progressive character may present bone atrophy or proliferative character. The frequency of malignant transformation in irradiated bone is discussed. It appears that it is much more frequent if irradiation is applied to the diseased bone. Irradiation of previously undamaged bone is a relatively safe procedure. (auth)

4877 RADIATION THERAPY FOR CERVICAL CANCER: LATE EFFECTS ON LIFE SPAN AND ON LEUKEMIA INCIDENCE. Zippin, Calvin (Univ. of California, San Francisco); Bailar III, John C.; Kohn, Henry I.; Lum, Diana; Eisenberg, Henry. Cancer; 28: No. 4, 937-42(Oct 1971).

To investigate life-shortening after partial body exposure, survival of 497 patients whose primary treatment was exclusively with x-rays and radium for squamous cell cancer of the cervix (localized and regional stages) is under continuing study. To eliminate early deaths due to cancer and to provide maximal follow-up time, the group includes only those who survived at least 5 yrs and who were under age 55 at time of diagnosis. The patients were treated in 1932 to 1951 and were drawn from the University of California and Connecticut State Tumor Registries. Pelvic regional dose was calculated for each patient. Three dose-groups were formed: <23 Mgm-rads, 23 to 31 Mgm-rads, and 32 to 54 Mgm-rads. When dose groups were compared with one another within stage and registry, and also after pooling stages and registries, no statistically significant differences in survival were found. When uterine cancer deaths were excluded to adjust for the possibility that unsuccessful treatment might have masked the life-shortening effect under study, again no association was found between radiation dosage and survival. In excess of seven cases of leukemia were predicted for the 10-yr period of 5 to 14 yrs after treatment. To this time, no deaths have been attributed to leukemia. (auth)

Radiation Effects on Plants

Refer also to abstracts 4684, 4695, and 4733.

4878 EFFECT OF GAMMA RADIATION ON THE ANTHOCYANIN AND FLAVONOL PIGMENTS OF CRANBERRIES (VACCINIUM MACROCARPON AIT.). Lees, David Harvard. Amherst, Mass.; Univ. of Massachusetts (1971). 237p. University Microfilms Order No. 71-23,644.

Thesis.

The bright attractive color of the American cranberry (Vaccinium macrocarpon Ait.) is due primarily to the red anthocyanin pigments and to a minor contribution by the yellow flavonol pigments. The effects of gamma radiation on the post-harvest synthesis of these pigments was studied with the hope of enhancing their production. A procedure for the qualitative and quantitative determination of cranberry flavonols was developed, based on thin-layer chromatography. This method gave very satisfactory results and was employed throughout the investigation for this purpose. Three different maturities of cranberries, based on their degree of coloration, were used and these included white-pink, half-red and full-red fruit. Radiation treatment was at levels of 150 and 300 krad, and storage temperatures for subsequent pigment development ranged from 34° to 50°F. The changes that occurred in the anthocyanin and flavonol pigments of the cranberries were determined at regular intervals, using quantitative techniques, during the post-harvest storage periods. Radiation had a beneficial effect on the pigmentation of the full-red cranberries and resulted in a significant increase in the anthocyanin and flavonol content. The degree of increase was dependent on the dose level and storage temperature and increased as these factors increased. The increase was found to be due to an increased rate of pigment synthesis and not a total greater synthesis since at the conclusion of the experiments all of the samples had approximately the same pigment levels. The gross effects of gamma radiation on the cranberries included minor softening and a stimulation of pigment production in the endocarp region of the fruit, resulting in internal coloration of the berries. The mode of action of radiation on the synthesis of anthocyanins and flavonols was not elucidated; however, it is speculated that radiation induced ethylene production was responsible for the stimulated biosynthesis of the pigments. It was concluded that gamma radiation does have an effect on the biosynthesis of cranberry pigments and that the maturation stage of the fruit was the controlling factor in determining the degree of response to radiation treatment. (Diss. Abstr.)

4879 IMPORTANCE OF CELLULAR ENERGY METABOLISM FOR THE SPARING EFFECT OF DOSE FRACTIONATION WITH ELECTRONS AND ULTRAVIOLET LIGHT. Kiefer, Juergen (Justus Liebig Univ., Giessen, Ger.). Int. J. Radiat. Biol.; 20: No. 4, 325-36(1971).

The sparing effect of dose fractionation with electron and uv exposure was investigated in diploid yeast Saccharomyces cerevisiae. Sparing was observed at the same rate and to the same extent in air or under hypoxia if the cells were held in a glucose-containing nutrient medium. With non-fermentable substrates, e.g. lactate or acetate, the process was slower in the aerated sample, and absent in hypoxia. The action of some metabolic inhibitors known to interfere with cellular energy production was also studied. The sparing effect was diminished if ATP production was inhibited at an early stage of the metabolic pathway. The results are interpreted by assuming that energy-rich metabolites are essential for the sparing effect. Implications for radiotherapy are discussed. (auth)

4880 RESPONSE OF SEVERAL RICE VARIETIES TO FAST NEUTRONS. Soriano, J. D. (Univ. of the Philippines, Luzon). Radiat. Bot.; 11: No. 5, 341-6(Oct 1971).

Dormant seeds of eight varieties of rice were compared at a dose of 2.4 krad of fast neutrons under similar pre- and post-irradiation conditions. According to seedling height and seed-set reductions, the different varieties were classified into either a radiosensitive or resistant group. The varieties of hybrid origin gave a relatively high frequency of M_2 seedling mutations compared with the inbred varieties. These results are briefly discussed. (auth)

4881 BETA RADIATION DAMAGE TO VEGETATION FROM CLOSE-IN FALLOUT FROM TWO NUCLEAR DETONATIONS. Rhoads, William A. (EG and G, Inc., Goleta, Calif.); Platt, Robert B. Bioscience; 21: No. 22, 1121-5(15 Nov 1971).

The Plowshare project nuclear events, Palanquin and Cabriolet, were approximately the same size, each less than 5 kt. They occurred at different times, however, Palanquin on 14 April 1965 and Cabriolet on 26 January 1968, about 1.0 km apart in the far northwest corner of the Nevada Test Site on Pahute Mesa, southwestern Nevada, in Nye County. This area, in the southern end of the Great Basin Desert, is gently rolling with a mean elevation of 2000 meters. Its surface consists primarily of outcroppings of trachyte lava alternating with areas of shallow alluvial soils. The area is crossed by shallow intermittent water courses. These higher elevations in southwestern Nevada are covered by typical Great Basin Desert vegetation. The dominants are two species of sagebrush, Artemisia arbuscula and A. tridentata, Juniperus osteosperma, Grayia spinosa, two species of Mormon Tea, Ephedra viridis and E. nevadensis Wats., and several grasses. Data are presented on the effects of β radiation from close-in fallout on the survival of the two species of sagebrush. Results are compared with data on sagebrush exposed to a ^{60}Co γ source over a 34-day period. (C.H.)

4882 EFFECTS OF GAMMA RADIATION ON PENICILLIUM EXPANSUM L. III. ON NUCLEIC ACID METABOLISM. Chou, T. W.; Salunkhe, D. K.; Singh, B. (Utah State Univ., Logan). Radiat. Bot.; 11: No. 5, 329-34(Oct 1971).

Penicillium expansum was grown in Czapek-Dox broth after the suspensions of conidia were irradiated with 50 and 100 krad of radiation. The dry weight of mycelia in irradiated cultures was lower than those in the controls, while the contents of RNA and DNA were higher 1 to 2 days after post irradiation incubation. The RNA and DNA contents remained higher up to the fourth day of incubation, then declined and reached the same level as that of the controls by the fifth day of incubation. When the fungus was grown in the medium containing thymine-2-^{14}C, radioactivity was found in both the DNA and RNA of the mycelium. Chemical and isotopic analyses showed no gross radiation-induced degradation of DNA and RNA in the fungus during an 8-hr post irradiation incubation. (auth)

4883 RELATION OF MORPHO-PHYSIOLOGICAL EXPRESSION OF BARLEY TO GAMMA RADIATION EXPOSURE. Joshi, R. K.; Pandey, D. P.; Dave, I. C.; Gaur, B. K. (Bhabha Atomic Research Centre, Trombay). Radiat. Bot.; 11: No. 5, 333-9(Oct 1971).

The influence of γ radiation on growth, nucleic acids, and protein metabolism was investigated in barley. Dry barley seeds irradiated with ^{60}Co γ rays up to 62 kR were germinated and grown in the dark. All determinations were made on the 7th day and expressed on a per shoot basis. A linear inverse relation was found to exist between radiation exposure and growth, as well as with macromolecular contents, from 13 to 55 kR. Regression of these criteria on radiation exposure was highly significant. The radiation-induced decrease worked out on the basis of the regressions was found to be as follows: Free nucleotides > DNA > Freshweight = Free amino acids > Protein > RNA > Shootlength. (auth)

4884 GROWTH DELAY AND SALTANT FORMING IN IRRADIATED DIPLOID YEAST. Bliznik, K. M. (Scientific-Research Inst. of Radiology, Obninsk, USSR). Stud. Biophys.; 26: No. 3, 183-90(1971). (In Russian).

It is shown, that among colonies growing out of irradiated yeast cells, morphologically altered colonies (saltants) are found. The frequency of the saltants increases with the dose of irradiation. The number of colonies growing later than unirradiated control also increases with dose. The rate of saltants increases from early forming colonies to later forming ones. It is suggested that the saltant forming and growth delay are not independent of one another. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 4685, 4688, 4694, 4782, 4830, and 5902.

4885 (NYO-4171-3) RADIATION RESPONSE OF BACTERIAL RADIATION REPAIR SYSTEMS. Bruce, Alan K. (State Univ. of New York, Buffalo, Dept. of Biology). 31 Dec 1971. Contract AT(30-1)-4171. 18p. Dep. NTIS.

Investigations were conducted to test the hypothesis of whether lethality results from radioinduced damage to one or more components of the cell's repair system. Micrococcus radiodurans was used for studies on whole cells exposed to ultraviolet and graded doses of x rays. Results indicated that x-ray exposure did not affect the process of dimer excision in uv-repair at low doses. At higher doses (over 600 kR) a decrease in excision rate was seen, but was of considerably less magnitude than the effect on survival at the same dose. The uptake of tritium-labeled DNA was studied under various transformation conditions and observations were made on effects of uv irradiation of transforming DNA introduced into recipients of graded x-ray exposure. Basic properties of the T-7 phage-Escherichia coli system were studied and initial tests were made of the phage on E. coli B/r as a host to determine conditions for measurement of dimer excision of uv-irradiated phage by the x-irradiated host. Studies were also conducted on energy-coupling of radiation repair and DNA repair by sucrose gradient analysis. (H.L.W.)

4886 EFFECT OF GAMMA IRRADIATION ON THE SURVIVAL OF AZOTOBACTER CHROOCOCCUM. El-Hadidy, Tomader T.; Abdel-Salam, M. A. (Desert Inst., Cairo). Isotope Radiat. Res.; 4: 63-9(Jun 1971).

Suspensions of two pure cultures of Azotobacter chroococcum isolated from Delta and Mediterranean calcareous soils were exposed to gamma radiations at the levels of 0.1, 0.25, 0.5, and 0.75 Mrad from a ^{60}Co source, 230 Ci. The irradiated samples as well as the control were incubated for 30 days, and periodic determinations were made on Azotobacter counts. The results showed a definite relation between the radiation dose level and the survival rate of the two organisms. With the increasing exposure level there were increases in the percent of irreversibly damaged cells. Reactivation of damaged cells was generally complete at the radiation levels below 0.75 Mrad with respect to the Delta soil organism and below 0.25 Mrad in the case of the calcareous soil organism. There were differences in response to irradiation, pertaining to differences in the division mechanism of the two studied organisms. This could be related to differences in their environmental conditions; being isolated from fertile and highly calcareous soils respectively. (auth)

4887 ISOLATION, PURIFICATION, CHARACTERIZATION OF AN X-RAY INDUCED MURINE LEUKEMIA VIRUS FROM C57BL MICE. Walker, Etta Frances. Stanford, Calif.; Stanford Univ. (1971). 63p. University Microfilms Order No. 71-23,569.

Thesis.

Radiation leukemia virus (RadLV) was isolated and purified from the plasma of leukemic W/FU rats. The type of nucleic acid contained in the virion was identified using acridine orange staining; and the sedimentation behavior of the virus and of extracted viral nucleic acid was studied. Using both discontinuous and continuous sucrose gradients, purified RadLV of high titer that was infectious when inoculated intrathymically into C57BL mice, from which it was originally isolated, could be obtained. RadLV specimens prepared using a pseudoreplication technique appeared to be more or less spherical in shape with electron dense centers and of 100 mμ average diameter when observed in the electron microscope. This description is comparable to that reported previously for this virus and for RNA tumor viruses in general. Of four buffer systems used in the purification procedure (phosphate buffered saline, pH 7.2; phosphate buffered saline without divalent cations with 0.001 M EDTA, pH 7.2; 0.01 M Tris-HCl, 0.001 M EDTA, 0.10 M NaCl, pH 7.4; and 0.153 M sodium citrate, pH 6.7), phosphate buffered saline proved to be the best buffer for the maintenance of viral integrity. RadLV particles sedimented in two distinct zones, a fast zone (A particles) having a sedimentation constant of $675S_{20,w}$ and a slow zone (B particles) having a sedimentation constant of $559S_{20,w}$. Sedimentation constants reported for other RNA tumor viruses are in the same range as these values; however, the RadLV particles are peculiar in that both types band at the same density (1.16 gm/ml) on sucrose gradients, appear identical under the electron microscope, and are of approximately equal infectious titer. Similar behavior has been reported for the Rauscher murine leukemia virus, except the slower sedimenting form of this virus appears to contain most of the leukemogenic activity. RadLV(A) particles and RadLV(B) particles probably differ in shape at a level not detectable in the electron microscope. Using acridine orange staining, it was shown that both RadLV(A) and RadLV(B) particles contain single-stranded RNA. The intact extracted RadLV RNA behaved identically to the RNA extracted from the Bryan strain Rous sarcoma virus [RSV(RAV-1)] when sedimented, and RadLV RNA was found to have a sedimentation constant of $71S_{20,w}$. On the basis of information derived for RadLV from these studies, it is apparent that RadLV behaves similarly to the other known RNA tumor viruses. (Diss. Abstr.)

4888 DNA-STRAND BREAKS IN TWO STRAINS OF ESCHERICHIA COLI AFTER EXPOSURE TO γ RAYS. Stavric, S.; Dighton, M.; Dickie, N. (Dept. of National Health and Welfare, Ottawa). Int. J. Radiat. Biol.; 20: No. 2, 101-10(1971).

A progressive decrease in the sedimentation rate of the DNA from Escherichia coli, wild type (parent strain), and the radioresistant mutant 6γ, indicating single-strand breaks in double-stranded DNA, was obtained after exposure of the strains to an increasing dose of γ-rays. Sedimentation of the DNA from irradiated cells of E. coli 6γ was restored to the pre-irradiation rate after a period of post-irradiation growth. No such effect was obtained with irradiated cells of the parent strain. Amino-acid starvation or addition of chloramphenicol after irradiation inhibited the restoration of the sedimentation rate of DNA. (UK)

4889 EFFECTS OF γ-RADIATION AND HEAT ON THE GERMINATION OF SPORES OF CLOSTRIDIUM BOTULINUM TYPE E. Ando, Yoshiaki (Hokkaido Inst. of Public Health, Sapporo). J. Radiat. Res.; 12: No. 1, 29-36(Mar 1971).

Spores of Clostridium botulinum type E were exposed either to various doses of γ-rays or to lethal and sublethal temperatures, then the effects on germination were studied by using the following two defined media: (A) L-alanine + glucose + bicarbonate and (B) L-alanine + lactate + bicarbonate. An increased inhibition of germination either by raising the temperature or by increasing the dose level was observed when medium A was used. On the other hand, activation by heat, but no activation by γ-radiation, was observed when medium B was used. The heat activation was unaffected by additional pre- or post-irradiation. The amount of DPA released from spores by treatment with heat increased progressively with elevating temperatures, whereas no detectable amount of DPA was released by γ-irradiation at any of the sublethal doses applied. From the results that spores of Clostridium botulinum type E can be activated by heat but not by γ-radiation, could be explained on the basis of the difference in the manner of breaking dormancy between two agents. (auth)

4890 SENSITIZATION OF ESCHERICHIA COLI K-12 TO GAMMA RAYS BY NIACIN DEPRIVATION. Baptist, J. E.; Friesen, B. S. (Univ. of Kansas, Lawrence). Int. J. Radiat. Biol.; 20: No. 4, 401-4(1971).

Suspensions of a niacin-requiring mutant of Escherichia coli were exposed to doses of ^{60}Co γ irradiation from 0 to 100 krads, at a dose rate of 90 krads/hr, and also to ultraviolet irradiation from 0 to 1250 ergs/mm^2 at a rate of 10 ergs/mm^2/sec. Niacin starved cells were more sensitive to inactivation by γ radiation than the controls and there was a 2 to 3 fold increase in the slope of the survival curve. Niacin starvation did not change the ultraviolet sensitivity of the cells. The results were similar to those found for purine-starved cells, but different from those found with a ligase-deficient strain. (UK)

4891 EFFECTS OF ULTRAVIOLET LIGHT (UV) IRRADIATION ON RNA PHAGE IN H_2O AND IN D_2O. Furuse, Kohsuke; Watanabe, Itaru (Keio Univ., Tokyo). Virology; 46: No. 1, 171-2(Oct 1971).

Isotope effects in the whole phage and the RNA freed from its coat protein were investigated using phages MS2, GA, and Qβ. The uv-radiosensitivity of the three phages was determined in TM buffer (pH 7.6). The uv-radiosensitivity of the coat protein-free RNA from MS2 and Qβ was also determined in TM buffer on the basis of infectivity as a function of RNA concentration. It was apparent from these determinations that Qβ RNA was twice as sensitive as MS2 RNA, and that little difference exists between the sensitivity of the whole phage and that of the coat protein-free RNA. The uv-radiosensitivity of MS2 and Qβ phages in H_2O and in D_2O were compared and the isotope effects (tD_2O/tH_2O) were found to be 1.1 for MS2 and 1.2 for Qβ. The uv-radiosensitivity of Qβ RNA in H_2O and in D_2O was also determined. The value in H_2O was the same as the value in TM buffer at the same RNA concentration. The sensitivity of Qβ RNA in D_2O was slightly lower than that in H_2O and nearly the same isotope effect of 1.2 was obtained as in the case of the whole phage. Conclusions were drawn regarding the role of pyrimidine hydration and pyrimidine dimerization in the inactivation of RNA phage by uv irradiation. (E.R.B.)

Radiosterilization and Radiopreservation

Refer also to abstracts 4728 and 4868.

4892 (BARC/I-102, pp 34-65) FOOD TECHNOLOGY. Annual Report of the Biochemistry and Food Technology Division, 1969-70. (Bhabha Atomic Research Centre, Bombay (India)). 1970. INIS.

The maintenance and operation of two types of irradiators, namely, a food package irradiator and throughflow irradiator, are discussed. Some of the other topics discussed are: irradiation of cereals, legumes, and their products; compositional changes in irradiated wheat; storage studies with pre-packed and irradiated wheat products; irradiation of foodstuffs; radiation processing of ground nuts; radiation preservation of fruits and vegetables; storage studies of irradiated French fried potatoes; storage life of irradiated potatoes; irradiation of tomatoes; radiation preservation of sea foods; freshness test for sea foods; and development of packaging materials for irradiated fish. (INIS)

4893 (COO-2014-14) THREE-GENERATION REPRODUCTION STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN SWISS WHITE MICE. RESULTS OF ALL THREE GENERATIONS. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 21 Oct 1971. Contract AT(11-1)-2014. 37p. Dep. NTIS.

A two-year chronic and three-generation reproduction study

employing Swiss albino mice fed low dose irradiated papayas was conducted. The results obtained during the reproduction portion of the experiment are tabulated. Investigation of the following parameters revealed no differences between test and control animals which could be attributed to the ingestion of low dose irradiated papayas: body weight gain; mortality and reactions; hematologic and clinical blood chemistry; pathologic studies; and reproductive performance. (auth)

4894 (COO-2014-15) TWO-YEAR CHRONIC ORAL TOXICITY STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN ALBINO RATS. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 21 Oct 1971. Contract AT(11-1)-2014. 51p. Dep. NTIS.

Two years of feeding low dose irradiated papayas to groups of albino rats revealed the following results. Statistical comparisons of total weight gains after 12 and 24 months revealed significant depressions for male rats fed non-irradiated papayas and irradiated papayas. However, the weight gains of the male rats fed irradiated papayas were not significantly different from the weight gains of the male rats fed non-irradiated papayas. Females fed non-irradiated and irradiated papayas exhibited weight gains which were not significantly different from control weight gains. Rats fed irradiated papayas ate amounts comparable to the amounts eaten by rats fed non-irradiated papayas or standard rat ration. None of the deaths that occurred during the study could be attributed to the ingestion of irradiated papayas. No untoward behavioral reactions were noted among any of the animals employed in the study. The results of studies on hematology and clinical blood chemistry, which were conducted on two animals of each sex from each group after 6, 12, 18, and 24 months of feeding, revealed no outstanding differences between rats fed irradiated papayas and rats fed non-irradiated papayas or control ration. (auth)

4895 (COO-2014-16) THREE-GENERATION REPRODUCTION STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN ALBINO RATS. RESULTS OF ALL THREE GENERATIONS. (Industrial Bio-Test Labs., Ind., Northbrook, Ill.). 25 Oct 1971. Contract AT(11-1)-2014. 38p. Dep. NTIS.

A two-year chronic and three-generation reproduction study employing albino rats fed low dose irradiated papayas was conducted. The following results were obtained during the reproduction portion of the experiment. Investigation of the following parameters revealed no differences between test and control animals which could be attributed to the ingestion of low dose irradiated papayas: body weight gain; mortality and reactions; hematologic and clinical blood chemistry; pathologic studies; and reproductive performance. (auth)

4896 (COO-2014-17) TWO-YEAR CHRONIC ORAL TOXICITY STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN SWISS WHITE MICE. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 25 Oct 1971. Contract AT(11-1)-2014. 38p. Dep. NTIS.

Two years of feeding low dose irradiated papayas to groups of albino mice revealed the following results: statistical comparisons of total weight gains after 10 weeks revealed no significant differences among mice fed the control diet, non-irradiated papayas, or irradiated papayas; body weights remained virtually unchanged from the tenth week through the twentieth month; after the twentieth month, body weight losses were observed in all groups. These weight losses resulted from general debilitation due to old age. Mice fed irradiated papayas ate amounts comparable to the amounts eaten by mice fed non-irradiated papayas or standard mouse ration. None of the deaths that occurred during the study could be attributed to the ingestion of irradiated papayas. No untoward behavioral reactions were noted among any of the animals employed in the study. The results of studies on blood which were conducted on two animals of each sex from each group after zero, three, six, 12, 18, and 24 months of feeding, revealed no outstanding differences between mice fed irradiated papayas and mice fed non-irradiated papayas or control ration. Pathologic studies were conducted on animals from all groups after 3, 6, 12, and 18 months of feeding and again at the time of sacrifice (24 months). Gross pathologic observation revealed no changes which could be related to the ingestion of irradiated papayas. Organ weights or femur lengths did not differ significantly among treatment and control groups. Histopathological studies conducted at the same time intervals confirmed the absence of pathologic changes which could be related to the ingestion of irradiated papayas. (auth)

4897 (EUR-4617) MEASURABLE CHANGES IN IRRADIATED FOODSTUFFS. Use of Chromatographic, Electrophoretic, and Spectrophotometric Methods for the Analysis of Aromatics, Fatty Acids, Natural Dyes, and Enzymes. Drawert, F. (Technische Universitaet Muenchen, Freising-Weihenstepha (West Germany). Institut fuer Chemisch-Technische Analyse und Chemische Lebensmitteltechnologie); Emberger, R.; Westphal, N.; Rolle, K.; Tressl, R. (Karlsruhe Univ. (West Germany). Institut fuer Lebensmittelchemie). 1 Dec 1970. 44p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 4,40.

Irradiation of apples and bananas with a dose of 200 Krad caused an inhibition in the formation of aromatic substances; effects were also observed on degradation, changes in the ripening process, increased concentration of free amino acids, changes in protein composition, and respiratory enzyme activities. Irradiation of beef with 5,000 Krad caused degradation of oxyhemoglobin and oxymyoglobin and modifications of lipids and fatty acids. Irradiation of dried egg powder caused degradation of lutein, the effect being proportional to the radiation dose; changes in lipids and fatty acids also occurred. Methods included gas chromatography, spectrophotometry, disc electrophoresis, determination of enzyme activity, and analysis of amino acids. (H.L.W.)

4898 (INIS-mf-51) EFFECTS OF IONIZING RADIATION ON THE SUSCEPTIBILITY OF STORE PESTS. Naharin, Avraham (Technion-Israel Inst. of Tech., Haifa). Feb 1970. 140p. (In Hebrew). INIS.

Information on the control of insect pests by ionizing radiations, in particular the effects of low doses on direct control is reviewed. Several aspects of the susceptibility of insect pests to various radiation exposures were examined. All four developmental stages: eggs, larvae, pupae, and adults were investigated. It was concluded that a more economical and effective control could be achieved by a disinfestation with a high dose-rate at plants with powerful radiation sources. (INIS)

4899 ATOMIC ENERGY AND ALIMENTARY TECHNIQUES. Leveque, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Ind. Aliment. Agr. (Paris).; 88: No. 3, 331-46(Mar 1971). (In French).

Gamma radiation from ^{60}Co and ^{137}Cs was used to study food preservation by irradiation. A radiation dose of 10,000 rads inhibited the germination of potatoes, onions, and garlic. A dose of 20,000 rads resulted in the disinfestation of insects in stored grain. Doses of 100 krads were necessary to increase the preservation time of eggs contaminated with Salmonellae, and also of fruit and fish. Pasteurization of minced meat was studied in France. The destruction of some vitamins by irradiation was observed. The control of the doses received by the potatoes was studied. (auth) (France)

4900 INFEASIBILITY OF IRRADIATING FRESH FRUITS AND VEGETABLES. Maxie, E. C.; Sommer, N. F.; Mitchell, F. G. (Univ. of California, Davis). HortScience 6: No. 3, 202-4(Jun 1971).

Results are summarized from studies extending over a 15-year period on the feasibility of using radiation processing to extend the shelf life of fruits and vegetables. Data are summarized on the radiation dose required to inhibit sprouting, ripening, and the growth of fungi which cause spoilage, and the disinfestation of insects on 20 fruits and vegetables. Data are included on the desired technical effect on each commodity and the phenomena limiting commercial applications of radiation processing of each commodity. Only six of the commodities (asparagus, bananas, mushrooms, papayas, potatoes, and strawberries) can tolerate radiation doses approaching beneficial levels, and of these only the papaya shows appreciable technical promise for irradiation for disinfestation of Hawaiian fruit fly. (C.H.)

4901 STERILIZATION OF THE COTTON LEAF WORM SPODOPTERA LITTORALIS BOISD, BY GAMMA RADIATION. El-Badry, E. A.; Hosny, M. M.; Wakid, A. M.; Sallam, H. A. (Atomic Energy Establishment, Inshas, Egypt). Isotope Radiat. Res.; 4: 71-6(Jun 1971).

As far as reduction in egg viability was concerned, one-day-old pupae of Spodoptera littoralis Boisd. were more sensitive to gamma radiation than either 4-day-old or full grown pupae. Generally, there was a highly negative relationship between dose and egg hatchability. At all tested pupal ages, the females were more radiosensitive than males. When treated females were paired with treated males, fertility was drastically reduced. Irradiation of full grown pupae with higher doses than the sterilizing dose showed reduced adult emergence, fecundity, and longevity. Adult malformations increased gradually with the increase of the dose. (auth)

4902 BEHAVIOR OF UREASE ADDED TO UNSTERILIZED, STEAM-STERILIZED, AND GAMMA RADIATION-STERILIZED BLACK SPRUCE HUMUS. Roberge, M. R. (Dept. of Fisheries and Forestry Canada, Ste. Foy, Quebec). Can. J. Microbiol.; 16: 865-70(Sep 1970).

Because of the widespread use of urea fertilizer, it became evident that an assessment of urease addition on natural ureolysis

was pertinent. Samples of each layer of the surface organic horizon of a black spruce (Picea mariana Mill.) stand at Baie-Comeau, Quebec, were treated with urease then tested for ureolysis activity. Added urease was active in all samples; the increase of activity was affected by the type of sterilization treatment used and the layer of the surface organic horizon. Additional ureolysis was greatest in unsterilized samples, less in radiation-sterilized samples, least in steam-sterilized samples, and decreased with depth of layers. Autoclaving inhibited activity of urease added previously or subsequently while irradiation had a lesser effect. Every layer had an upper limit of urease adsorption and was characterized by a definite capacity to adsorb urease that increased with depth of layers. The pattern of ureolysis observed when urease was added to solutions obtained from layer samples was similar to that observed when urease was added to the layer samples themselves. All solutions inhibited the action of added urease. (auth)

4903 STERILIZATION OF DIET FOR LABORATORY ANIMALS BY IRRADIATION. Sato, Tomotaro (Japan Atomic Energy Research Inst., Takasaki). Shokuhin Kogyo; 13: No. 24, 89-92(Dec 1970). (In Japanese).

Germ-free animals, or SPF (specific pathogen free) animals, play important roles in research studies on physiology, biochemistry, nutriochemistry, immunology, radiobiology, dentrogy, anatomy, and surgery. Pellet-type animal food was irradiated with 0.5 to 3.0 Mrad dose with dose rate of 0.5 Mrad/hr, utilizing a 80,000 Ci ^{60}Co γ source. Radiation-resistant Clostridium in feed was completely sterilized with 1.7 Mrad, therefore 2.0 to 2.5 Mrad is sufficient as the sterilization dose. Breeding studies on rats proved clearly that those on a radiosterilized diet surpassed the group fed with steam sterilized feed in amount of feed consumption, weight increase, and number of offspring. Destruction of vitamins was not noticeable. Application of the germ free diet to silkworms and SPF pigs was also investigated. Though irradiation cost is rather expensive, and transportation expense to irradiation plant must be also added, it can be used practically when the above merits and labor saving problem are considered. (Japan)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 4526.

4904 (AEC-tr-6873) HIGH TEMPERATURE INORGANIC COMPOUNDS. Samsonov, G. V. Translation of Vysokotemperaturnye Neorganicheskie Soedineniya, Izdatel'stvo Naukova Damka, Kiev, 1965. 624p. (TT-67-59068). Dep. NTIS.

Fifty-seven papers are included which were presented at three Russian seminars on boron, its compounds, and alloys (Dec. 1962); on refractory metals and their compounds (April 1963); and on recovery and physico-chemical properties of carbides. (D.L.C.)

4905 (ORNL-4770) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1971. Peterson, Sigfred (comp. and ed.) (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 230p. Dep. NTIS.

Progress reported in the division is summarized in forty-two sections. A separate abstract was prepared for each of thirty-five sections containing information on nuclear materials. (J.R.D.)

For abstracts of individual sections see: 4466, 4502, 4503, 4909–4912, 4922–4926, 4944–4947, 4964–4966, 4979–4983, 4990–4993, 4998–5000, and 5029–5032.

4906 (ORNL-TM-3540) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1971. Patriarca, P. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 146p. Dep. NTIS.

Research and development is reported on fast breeder reactor fuels, advanced fast breeder reactor fuels, fuel cladding and reactor structural materials, welding techniques for stainless steel reactor components, corrosion of reactor materials, nondestructive test methods for reactor materials, neutron absorber materials, materials for isotopic power programs, properties of refractory metals and alloys, tungsten metallurgy, and radiation effects on reactor metals. (J.R.D.)

4907 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. September 1971. Band 5, Heft 9. 151 Referate (Register-Nr.3282-3558), 60 Referate (Register-Nr.424 T-483 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. September 1971. Vol. 5, No. 8. 151 Abstracts (Register No. 3282-3558), 60 Abstracts (Register No. 424 T-483 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 98p. (In German and English).

4908 TOOLS AND TECHNIQUES IN PHYSICAL METALLURGY. VOLUME 1. Weinberg, F. (ed.). New York; Marcel Dekker, Inc. (1970). 410p. $24.50.

Information is presented aimed at furthering understanding of new metallurgical instruments and techniques. Chapters are included on temperature measurement, x-ray diffraction, crystal growth, metallography, microscopy, electron probe microanalysis, and spectrography. (J.R.D.)

Corrosion and Erosion

4909 (ORNL-4770, pp 28-30) SURFACE PHENOMENA. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The oxidation properties of a series of uranium-base alloys containing Nb, Zr, Ti, and Mo were studied. Special emphasis was placed on characterizing the complex morphology of the oxide films and on determining the origin of the oxide film stresses. Ternary Ta-W-Hf alloys were also shown to be subject to large stresses during oxidation; these stresses are probably instrumental in producing a period of catastrophic oxidation for such alloys during which oxidation proceeds with explosive violence. The movement of fluorine- and phosphorous-rich marker layers during the growth of anodic oxide films on tantalum was studied in order to better understand the mechanism of anodization. An elastic stress (maximum 20,000 psi) had a small but detectable effect on the diffusion rate of ^{95}Nb in a tantalum-base alloy. The structure and properties of thin oxide films were reviewed with regard to the manner in which they influence the oxidation process for metals. (auth)

4910 (ORNL-4770, pp 90-4) CORROSION OF ADVANCED STEAM GENERATOR ALLOYS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Steam generator alloys with ground surfaces and with the effects of grinding removed by electropolishing were exposed in steam for up to 14,000 hr at 650 and 595°C. Electropolishing substantially increased the corrosion of Incoloy 800, moderately increased it for Inconel 600, but slightly decreased it for Inconel 625 and Hastelloy X. Although the amount of corrosion on electropolished Incoloy 800 was comparatively large, the projected total attack in 20 years was still impressively low because its second-stage corrosion rate decreases significantly with time. Stress-corrosion tests on weldments using conventional U-bend specimens in superheated steam contaminated with NaCl and oxygen failed to produce cracks. Under conditions that incorporated cycling periodically to the steam saturation temperature and introducing 25 ppM NaCl and 50 ppM O_2, many weldments with ground surfaces failed. Inconel 625 weldments did not fail under any conditions of surface treatment. (auth)

4911 (ORNL-4770, pp 95-6) SODIUM CORROSION IN LMFBR SYSTEMS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Several vanadium alloys were tested at 600°C in static capsules to determine the effect of alloying elements on the solubility and diffusivity of oxygen in vanadium. Chromium, molybdenum, and iron lower the oxygen solubility much more than tantalum and niobium. Equations were derived to determine the effects of alloying components on the oxygen diffusion coefficient; experiments designed to test the equations showed in some instances that an essential boundary condition is not met experimentally. (auth)

4912 (ORNL-4770, pp 97-9) SODIUM REMOVAL AND CAUSTIC EFFECTS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Cleaning procedures for removing sodium from metallic surfaces were evaluated with respect to their corrosion effects. An apparatus was constructed to determine the effect of sodium on the oxidation of stainless steel as a function of sodium leak rate and temperature. The ALCO/BLH steam generator was dissected and examined to learn the cause of cracking in the lower tube sheet. (auth)

4913 UNCRACKED ELECTROLYTIC Ni–Mo ALLOY PLATING AND HEAT TREATMENTS TO IMPROVE THE ACID CORROSION RESISTANCE. Vu Quang Kinh; Chassaing, E.; Bourelier, F.; Montuelle, J. M. (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Corros.-Trait., Prot., Finition; 19: No. 5, 237-48(Aug-Sep 1971). (In French).

Crack free electrodeposited Ni-Mo alloy plating was obtained from a complexing sodium citrate based bath under certain specified conditions (particularly with a cathode current density above a certain threshold). The crude electrolysis deposits have a relatively low resistance to hydrochloric acid. This resistance improves after the appropriate heat treatment and becomes comparable with that of cast Ni-Mo alloys. Investigations using x-ray techniques and optical and electron micrographs demonstrated a definite evolution in the microstructure of the Ni-Mo deposits after heat treatment. The optimum corrosion resistance was shown to be closely linked with the degree of perfection of the crystalline structure. (France)

4914 STUDY OF SURFACE OXIDATION OF TUNGSTEN BY THE SECONDARY ION EMISSION METHOD. Rybalko, V. F.; Kolot, V. Ja.; Fogel, Ja. M. (Physical-Technical Inst., Kharkov). pp 1109-12 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The reactions of O with Ar ion-bombarded W surfaces were studied. Ions of W and W oxides identified include W^+, WO^+, WO_2^+, WO_3^-, W_2^+, W_2O^+, $W_2O_2^+$, $W_2O_3^+$, $W_2O_4^+$, $W_2O_5^+$, and $W_2O_6^+$. It was found that as the W surface temperature increases the W oxides with many 0 atoms bonded to one W atom disappear; instead of these atoms, oxides with low O content appear. (J.R.D.)

4915 MASS SPECTROMETRIC STUDY OF THE OXYGEN–RHENIUM SYSTEM. Weber, B.; Fusy, J.; Cassuto, A. (CNRS, Nancy). pp 1319-24 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Preliminary results on reactions in the Re–O system obtained using ultrahigh vacuum apparatus, in-line mass spectrometry, and flash desorption are reported. ReO_3 and atomic O were found to exist as desorption products. The reaction order of ReO_3 changed from 0.8 to 2 at high temperatures although only ReO_3 was produced. (J.R.D.)

4916 OXIDATION AND GAS ABSORPTION OF METALLO-CERAMIC TUNGSTEN DURING HEATING AND ROLLING IN AIR AND IN VACUUM. Gurevich, Ya. B.; Orzhekhovskii, V. L.; Osipov, V. G.; Ushakov, E. V.; Drobysheva, E. K. pp 51-5 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'-nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

The effects of temperature on oxidation during hot rolling and drawing were investigated. Measurements of parameters of rolling and drawing at constant temperature increase from 20 to 1200°C were made. It was found that gas surface penetration reaches 0.4 to 0.5 mm. (tr-auth)

4917 STUDY ON THE INTERNAL OXIDATION OF Ag–Be ALLOYS. Kimata, Hidemi; Nishi, Seiki (Nagoya Univ., Japan). J. Jap. Inst. Metals; 35: No. 6, 615-22(Jun 1971). (In Japanese).

The heat treatment of Ag–Be alloys was studied for electrical contacts. Silver alloys containing 0.10, 0.20, 0.45, and 0.56 wt % Be were heated at 820°C in various atmospheres. Atmospheres for heat treatment were nitrogen, $\sim 10^{-3}$ mm Hg, air, and oxygen. The hardness of Ag–Be alloys was measured at the cross section. Hardness of Ag–Be alloys after heat treatment increased to more than Hmv 120. Oxygen in the atmosphere of the heat treatment caused an increase in hardness. Experimental data showed that the hardening mechanism was due to the internal oxidation of Ag–Be alloys. Ag–0.20 wt % Be alloy was heated at 820°C in still air for 16 hr. After the heat treatment, the change of the beryllium content from the surface to the inner part was determined. Beryllium was concentrated in the hardening zone, while the beryllium depleted zone was formed in the center of samples. Formation of the concentrating and depleting zones of beryllium showed that the diffusion velocity of beryllium in silver could not be neglected as compared with that of oxygen. (auth)

Preparation and Fabrication

Refer also to abstract 4399.

4918 (NASA-SP-245) RECENT ADVANCES IN REFRACTORY ALLOYS FOR SPACE POWER SYSTEMS. A Conference held at Lewis Research Center, Cleveland, Ohio, June 26, 1969. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1970. 300p. (CONF-690665). NTIS.

Nine papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 4919–4921 and 4938–4943.

4919 (NASA-SP-245, pp 165-219) FABRICATION OF T-111 TEST LOOP SYSTEMS. Young, W. R. (General Electric Co., Cincinnati, Ohio). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

Fabrication of large T-111 components and alkali metal systems is described. As the project progressed, understanding of the welding characteristics and metallurgy of T-111 alloy was broadened. The corrosion loop fabrication was accomplished without undue difficulties, as evidenced by the welding of complex components. A boiler fracture occurred which required repair of a T-111 component which had been previously exposed to alkali metals. The boiler development test loop program provided the challenge of building components of a large T-111 alloy system. Concurrently, unique processes such as internal tube-to-header welding were applied to T-111 alloy. Each component provided a better understanding of the machining, forming, and welding processes required to fabricate large space power systems. (auth)

4920 (NASA-SP-245, pp 221-60) T-111 ALLOY CRACKING PROBLEMS DURING PROCESSING AND FABRICATION. Ekvall, R. A.; Frank, R. G.; Young, W. R. (General Electric Co., Cincinnati, Ohio). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

A review is made of T-111 cracking encountered at General Electric Nuclear Systems Programs Department during fabrication of advanced space power Rankine cycle system components since 1965. Cracking has been observed after machining, forming, and welding. A majority of crack incidents have been associated with welding. Although tungsten inert gas welding is the primary joining technique used, cracks have also been found after electron beam and spot tack welding. Cracking phenomena associated with each fabrication method are described with emphasis on weld related cracking. Preventive measures adopted for each type of cracking are reviewed. Possible causes for cracking, including attempts at correlating cracking incidents with material properties and processing history, are discussed. The frequency of crack occurrences and the requirements for highly reliable system components indicate the need for an investigation of the basic mechanism(s) underlying T-111 alloy cracking. (auth)

4921 (NASA-SP-245, pp 261-96) WELDABILITY OF TUNGSTEN BASE ALLOYS. Lessmann, G. G.; Gold, R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

The weldability of unalloyed tungsten and two tungsten alloys was evaluated. The alloys were W–25Re (wt %) and W–25Re–30Mo (at. %). These were evaluated as arc cast material and for the ternary alloy also as a powder metallurgy product. The most important aspect of welding unalloyed tungsten was that it is very sensitive to thermal shock. High preheat temperatures (to 1400°F) corrected this problem. W–25Re had improved thermal shock resistance but was shown to be basically hot tear sensitive in gas tungsten arc welding. Preheat temperatures of 1400°F were again beneficial. The powder metallurgy W–25Re–30Mo alloy displayed excellent weldability, whereas the arc cast material displayed extensive hot tearing and, hence, poor weldability. The anomalous hot tearing behavior of the arc cast W–25Re–30Mo alloy was ascribed to a very high sensitivity to oxygen contamination. The effects of postweld annealing, joint preparation, and aging for 1000 hours at temperatures to 3000°F were evaluated. The high temperature tensile strength of base metal, gas tungsten arc welds, and electron beam welds in W–25Re–30Mo was determined. (auth)

4922 (ORNL-4770, pp 78-81) FABRICATION DEVELOPMENT OF FAST BREEDER REACTOR CLADDING. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Methods to produce cheaper but higher quality of cladding are being studied. Two methods of tubing fabrication, planetary swagging and hot plug drawing, were investigated. The slow planetary swaging process does not appear economic compared with the more conventional processing procedures. Methods for hot plug drawing at temperatures up to 760°C were developed. The relationship between defects and mechanical properties at elevated temperatures is being examined. Cold worked tubing is more sensitive to surface defects than annealed tubing. At high stress and short creep-rupture lives, surface notches cause a reduced lifetime and lower ductility. A procedure was developed for producing, in material for mechanical testing, artificial defects that resemble the sharp surface defects found in some lots of tubing. (auth)

4923 (ORNL-4770, pp 82-9) WELDING DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The behavior of weldments in austenitic stainless steel at 370 and 650°C is being studied as a function of both welding process and variables within a process for application to LMFBR vessels and components. Submerged-arc welds exhibited lower creep-rupture strength and higher ductility in general than typical type 304 stainless steel base plate. Shielded metal-arc welds in general exhibited strength comparable with base plate. Weld-metal ductility decreased with increasing rupture life. From a study of the effect of certain minor elements including S, P, Si, B, and C, a controlled residual element filler metal possessing superior strength and ductility was developed for the FFTF vessel. A state-of-the-art review of the weldability of stabilized low-alloy steels was completed. Reports concerning the weldability of the stabilized steels have been contradictory. Poor weldability can be attributed to hot cracking in the heat-affected zone due to the melting of a niobium-rich eutectic. Low-carbon 2.25 % Cr–1% Mo weld metal was responsive to thermal cycling due to multipass welding techniques. This is particularly true of the low-carbon heat-affected zones, where the hardness increased from 129 to over 160 DPH. The strength of these alloys depends on the carbon level; however, the difference in as-welded strength at 565°C is reduced by a 700°C postweld heat treatment. (auth)

4924 (ORNL-4770, pp 115-19) TUNGSTEN METALLURGY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The capability for extruding tungsten alloy tubing was extended to include W–5% Re and W–2% ThO2. Chemical vapor deposition of W–5% Re was optimized. Welding techniques were evaluated,

including gas tungsten arc and electron beam with and without filler metals, for joining tungsten and W–25% Re. The creep strength of W–25% Re is significantly greater in low-pressure O_2 than in ultrahigh vacuum. A carbon-containing atmosphere lowers the creep strength of unalloyed tungsten. Preexisting gas bubbles in powder-metallurgy tungsten expand to form the creep cavities by the stress-directed diffusion of vacancies along the grain boundaries. A high-temperature irradiation experiment for EBR-II was designed and constructed to find the effect of irradiation temperature and alloying on the void formation and electrical properties of tungsten. (auth)

4925 (ORNL–4770, pp 128–30) JOINING RESEARCH ON NUCLEAR MATERIALS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Experimental compositions of Inconel base metal lost ductility when tested above 500°C and did not recover it. These results corroborate those of a previous study on Incoloy 800, where ductility was not recovered for compositions that did not contain titanium. Tensile tests at 650°C were completed on Incoloy 800 welds made with both experimental and commercially obtained filler metals. Two new alloys from International Nickel Company compared favorably with the recommended filler metal (Inconel 82). A microfissured electron-beam weld that joined an Inconel 600 tube to an Inconel 82-clad carbon steel tube sheet was investigated. The microfissure occurred in the overlay (the heat-affected zone of the weldment) at a location in which weld bead geometry led to a stress concentration. The microfissure was attributed to liquation of a niobium-rich phase during welding. The Schaeffler diagram, which is often employed for predicting the amount of ferrite in austenitic stainless steel welds, does not take into account the large effect of heat input. Further, high manganese contents lead to erroneous ferrite predictions. Alloys with 5% Mn, which are predicted by the diagram to be fully austenitic, contained from 3 to 8% ferrite. (auth)

4926 (ORNL–4770, pp 176–81) TRANSURANIUM PROGRAM. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The Transuranium Project is producing heavier transuranium elements by successive neutron captures. Target elements are removed, reprocessed to obtain the product actinides, and recycled to the HFIR. Special target elements of the higher isotopes are fabricated and irradiated, and product actinides are encapsulated. Programs to fabricate targets and rabbits for HFIR and special encapsulations for neutron and gamma sources, to evaluate the performance of the target elements, and to improve the processing equipment are described. Target elements loaded with ^{244}Cm, hydraulic rabbits with ^{244}Pu, ^{253}Es, and ^{252}Cf, 20 neutron sources of ^{252}Cf, and gamma sources were fabricated. Only four targets failed out of 44; two failures were predicted by the performance model and the others were satisfactorily explained. The target performance model has been updated to include individual pellet analysis and is being extended to cover the targets loaded with americium-curium oxide. For nondestructively determining the thermal conductivity of individual pellets, the limits of the work have been outlined, desired results stated, and feasibility of a technique with the desired sensitivity has been established. (auth)

4927 (RFP–1648) CHEMICAL MILLING TECHNIQUE FOR A MONEL–BERYLLIUM BRAZED JOINT. Briggs, John L.; Kochen, Robert L.; Macki, James M. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 15 Sep 1971. Contract AT(29-1)-1106. 3p. Dep. NTIS.

A technique has been developed for chemically milling a brazed joint between beryllium and Monel. The chemical milling technique involves two separate dissolution processes. Concentrated nitric acid is used in one of the milling processes to selectively dissolve the Monel and Cusil braze filler away from the beryllium. For the other milling process, 10 vol% hydrochloric acid is used to selectively dissolve the beryllium away from the Cusil braze filler and Monel. In both cases, the material that is not being dissolved is not attacked significantly. The chemical milling technique has been used successfully for residual stress analysis tests on the brazed joint. It is also applicable to other situations where a copper-alloy and beryllium are required to be separated by selective dissolution. (auth)

4928 METHOD OF ASSEMBLING COMPONENTS BY HARD SOLDERING. Stohr, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,048,135. 8 Mar 1971. Filed 2 Jun 1969. (In French).

A process for assembling components by hard soldering is described. The process is suitable for the components of nuclear reactor fuel elements cooled by a fluid such as CO_2, liquid Na, or light water. The procedure consists of making in at least one of the components to be assembled, at least two grooves, which are parallel to one another and to the straight part of the junction. A filament of hard solder is placed in one of the grooves, a second filament of another material being placed in another groove; this second material has a melting point similar to that of the hard solder filament. The assembly is then heated until the two filaments melt, i.e., until the mechanical assembly of the two components by the hard solder filament and the melting of the second filament in its groove. (France)

4929 APPARATUS FOR MANUFACTURING A REFRACTORY CONTAINER (CRUCIBLE OR SIMILAR DEVICE). Falcoz-Vigne, Rene; Le Roy, Camille; Lorrain, Christian; Tachon, Olivier (to Commissariat a l'Energie Atomique). French Patent 2,050,736. 22 Mar 1971. Filed 23 Jun 1969. (In French).

An apparatus for manufacturing a refractory container (crucible, mold, or similar device) is described. Among its uses, the production of uranium metal by magnesiothermy is envisaged. The crucible consists of a metallic envelope and a hollow core mounted axially within the envelope, the free space between the core and the envelope being filled with refractory material. The core is provided with a means of vibrating the apparatus so that a compact material is produced. (France)

4930 OBTAINING NICKEL–TIN–BORON ALLOY BY CHEMICAL REDUCTION. Tsupak, L. E.; Izmaylov, A. V. Zashch. Metal.; 5: No. 6, 688–9(1969). (In Russian).

Alloy coatings of Ni–Sn–B on steel were obtained from a solution containing 60 g/l nickel chloride 20% ethylenediamine 300 ml/l, NaOH 30 g/l, Na stannate 30 g/l, Na borohydride 1.6 g/l, at 95°C. The alloy yield in the form of a compact deposit was 97%, and coatings contained 8% Sn and 4.9% B and had microhardness 600 to 750 kg/mm^2. The coatings may be applied to Cu, Ni, Pt, and other metals. (Referativnyi Zh.)

4931 SELF-INDUCED SPUTTERING DURING ELECTRON-BEAM EVAPORATION OF Ta. Schuermeyer, Fritz L. (Air Force Avionics Lab., Wright-Patterson-AFB, Ohio); Chase, Wayne R.; King, Emerson L. J. Appl. Phys.; 42: No. 13, 5856–9(Dec 1971).

A pronounced nonuniformity in films of Ta deposited by electron-beam evaporation is reported. This effect is explained by the fact that positive Ta ions are generated during evaporation and, due to reflected electrons, the substrate acquires a high negative potential which accelerates the Ta ions and causes sputtering. (auth)

4932 FABRICATION OF SPUTTERING SOURCES BY PLASMA SPRAYING: TANTALUM–HAFNIUM MIXTURES. Locker, L. D.; Malm, D. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instrum.; 42: No. 11, 1696–8 (Nov 1971).

The possibility of fabricating sputtering sources by plasma spraying is investigated for the deposition of nitride films by reactive sputtering of tantalum–hafnium mixtures. Plasma sprayed and hot pressed sources were found to produce films with identical properties even though the plasma spraying process introduces more nonmetallic impurities into the source. Improvements in controlled atmosphere chambers for plasma spraying would enable this method to compete favorably with hot pressing in terms of cost, versatility in making various shapes and sizes, and elimination of bonding problems in the rf sputtering of dielectrics. (auth)

4933 INVESTIGATION OF THE PROCESS OF ROLLING OF TUNGSTEN IN VACUUM. Osipov, V. G.; Krupin, A. V.; Zarapin, Yu. L.; (and others). pp 34–6 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

Rolling of metalloceramic tungsten in vacuum using hard-alloy rolls under a wide range of temperatures and pressures was studied. It was found that the temperature has a great effect on specific pressure required to overcome the coefficient of friction. It was also found an increase of tungsten deformation is accompanied by an increase in specific pressure and a decrease in the coefficient of fraction. The results can be used in development of industrial regimes used for high-temperature treatment of tungsten by pressure. (tr-auth)

4934 REACTION OF MoO_3 WITH NIOBIUM CARBIDE. Kolchin, O. P.; Filipenko, V. V.; Buzina, O. T. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 38–43(1970). (In Russian).

The reaction of MoO_3 with Nb carbide is used for the production of Nb–Mo alloys; a study was made of the initial stage of this reaction using two experimental methods. The temperature for the onset of the reaction is between 480 and 500°C. Studies were also

made of the compositions of the gas and condensed phases between this region and 1100°C. The mechanism of the reduction is based on the evaporation of MoO_3; this process occurs with the formation of intermediate oxides and a lower carbide of Mo. (Referativnyi Zh.)

Properties Evaluations

Refer also to abstracts 4466, 5003, and 5660.

4935 (CEA-R-4180) STUDY OF URANIUM–TITANIUM ALLOYS WITH LOW TITANIUM CONTENTS (0 TO 1,5 WT. PERCENT). Linard, Michel (Commissariat a l'Energie Atomique, Valduc (France). Centre d'Etudes). Jul 1971. 114p. (In French). Dep. NTIS (U. S. Sales Only).

The addition of small quantities of Ti improved the mechanical properties of uranium. This improvement was most significant when rapid cooling took place after the γ phase had been reached. A relation exists between the elastic and plastic properties: the rupture and yield strengths increased uniformly with the Ti content, while the maximum elongation occurred for a Ti content between 0.4 and 0.6%. After quenching in water, alloys with Ti contents greater than 0.45% presented α'_a lamellar structures due to martensitic transformation from the γ phase. After quenching in oil, an α'_s structure was produced by nucleation and growth just above the M_s point. An extensive study of a 0.55% Ti alloy revealed: the alloy to be relatively insensitive to quenching conditions; a progressive recovery towards equilibrium conditions; interesting mechanical properties at high temperatures; an enhanced corrosion resistance compared to the uranium alloys with low Ti contents. (France)

4936 (EURFNR-910) EXPERIMENTAL INVESTIGATIONS OF CREEP BUCKLING OF THIN-WALLED HIGH-TEMPERATURE TUBES. Kaupa, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report KFK-1363. 83p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The danger of creep buckling is inherent in thin-walled tubes subjected to high external pressures at elevated temperatures, especially the fuel element cladding tubes of steam- or gas-cooled fast breeder reactors. The possibilities of such damage resulting in reactor operation are explained and the theories of creep buckling known in the literature are discussed. A survey of the experiments concerned with studies of creep buckling to the extent that they have been published is included. Creep buckling experiments which were carried out on thin walled tubes of reactor cladding material are described. They were intended to compare the lifetimes under creep buckling conditions determined in the investigations with statements by Hoff's theory of creep buckling, further to make a selection of materials, and to determine influences of spacer fins as integral parts of the tube wall relative to unfinned tubes. Accounts of the material used, the experimental setup, and the performance of the experiments are given. The results are represented in buckling time diagrams. In an interpretation of the test results, possible improvements of the creep buckling behavior are discussed and a preview is given of the effects on the creep buckling behavior by the operating conditions in a reactor. (auth)

4937 (MIT-3635-6) DEFORMATION AND FRACTURE OF ALPHA ZIRCONIUM ALLOYS (THE DUCTILITY OF ZIRCONIUM AND ITS ALLOYS). Final Report. Jensen, John A. Jr.; Backofen, Walter A. (Massachusetts Inst. of Tech., Cambridge). Sep 1971. Contract AT(30-1)-3635. 45p. (CONF-710821-1). Dep. NTIS.

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971).

The deformation and fracture of Zircaloy-4 and pure zirconium sheets having strong (0002) textures were studied under plane-strain compression at 20 to 800°C. Zircaloy-4 underwent a ductility transition from limited strain (0.1 to 0.3) to extensive fracture-free flow (>0.6) at about 300°C; pure zirconium was ductile at all temperatures. These differences were traced to others in deformation mechanisms. Below 300°C, Zircaloy-4 accommodated compression along [0001] by $\langle c + a \rangle$ slip; these dislocations were mainly confined to thin bands oriented close to $\{11\bar{2}4\}$. In pure zirconium $\{11\bar{2}2\}$ twinning followed by second and third-order retwinning tended to distribute strain more uniformly. Above 300°C both materials deformed by a combination of $\{10\bar{1}1\}$ twinning and $\langle c + a \rangle$ slip. Fracturing in Zircaloy-4 was by highly localized shear along thin bands of $\{11\bar{2}4\}$ orientation. From an analysis based on measured strain-hardening behavior and standard heat flow equations, it is suggested that localized shear can be brought about by thermal softening during slip-band formation. (autn)

4938 (NASA-SP-245, pp 1-18) REFRACTORY-ALLOY REQUIREMENTS FOR SPACE POWER SYSTEMS. Moss, T. A.; Davies, R. L.; Barna, G. J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

Various types of large nuclear space power systems are being investigated in support of missions projected for the post-1980 period. Among the approaches being considered to meet projected needs are the potassium Rankine cycle, Brayton cycle, and thermionic systems operating at relatively high temperatures in order to achieve high performance. All these systems require refractory alloys for structural purposes and employ alkali metals as process fluids. Heat for driving the systems would be supplied by a liquid-metal-cooled fast reactor. In the potassium Rankine engine, liquid potassium is vaporized in a boiler and used to power a vapor turbine similar to a central station steam-electric powerplant. Inert gas is compressed, heated, and expanded through a turbine in the Brayton cycle similar to air in the jet engine. Thermionic systems are dependent upon boiling electrons off a hot nuclearly heated surface and collecting them on a colder adjacent surface. The Rankine engine is characterized by a moderate system efficiency and small radiator; the Brayton cycle usually exhibits a high efficiency with a relatively large radiator but a relatively low system efficiency. The system specific weights for the Rankine and Brayton engines are approximately the same, while that of the thermionic system would be higher. Technology programs have been conducted in support of all three types of systems and, in particular, considerable effort has been placed on characterizing the refractory alloys which would be required for the construction of the systems. Papers are presented on the results of these refractory-alloy technology programs. (auth)

4939 (NASA-SP-245, pp 19-37) DEVELOPMENT OF HIGH STRENGTH TANTALUM BASE ALLOYS. Buckman, R. W. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.); Begley, R. R. (Westinghouse Research Labs., Pittsburgh, Pa.). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

The development of tantalum base alloys intended for application in advanced space power systems is described. For components such as piping in alkali metal Rankine cycle systems, radioisotope capsules, and fuel claddings in nuclear reactors, critical property criteria include excellent fabricability, good welding characteristics, long time thermal stability, and high creep strength. Tantalum base alloys which meet these criteria were achieved by a balanced combination of solid solution and dispersed phase strengthening, as typified by the alloy ASTAR-811C (Ta–8W–1Re–0.7Hf–0.025C). This alloy has creep strength significantly superior to T-111 (Ta–8W–2Hf) at temperatures up to 2600°F, without sacrifice of fabricability or welding characteristics. The DBTT of TIG welds is of the order of –250°F, and that of recrystallized base metal is below –320°F. Data are presented for tensile and long time creep properties of this alloy, and the role of carbide precipitates in improving high temperature strength is discussed. Greatly improved high temperature tensile and creep properties can be achieved by an increase in tungsten level and by a substitution of nitrogen for carbon. While this strength is obtained with some sacrifice in fabricability, the alloys of increased solute level are attractive for high temperature applications where weldability is not a critical design requirement. (auth)

4940 (NASA-SP-245, pp 39-73) THERMAL STABILITY OF REFRACTORY METAL ALLOYS. Lessmann, G. G.; Gold, R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

The thermal stability of refractory metal alloys which showed promise for application in high temperature space power systems was determined. Niobium and tantalum base alloys were evaluated including T-111, T-222, Ta–10W, FS-85, D-43, B-66, C-129Y, Nb-752, and SNb-291. These represent all of the commercial alloys prominent at the inception of the aging studies. T-111, T-222, and FS-85 eventually received the greatest emphasis because they demonstrated a superior balance of creep strength, weldability, and liquid metal corrosion resistance when evaluated in concurrent programs. The purpose was to screen the alloys for high temperature stability over long exposure times. This required that the effects on welds in particular be emphasized since welds represent severe metallurgical discontinuities whose behavior cannot be readily predicted. The alloys were thoroughly evaluated before and after aging to ascertain if degradation of mechanical properties occurred or if structural instability was otherwise noted. Bend testing for ductility changes as reflected in the bend transition temperature was emphasized as a screening technique.

Considerable success was achieved using this procedure since changes in ultimate ductility and transition behavior reflect a wide spectrum of structural interactions. Tensile testing, hardness determinations, and extensive optical and electron metallography were also employed. Electron beam and gas tungsten arc welds were evaluated as well as base metal. Instabilities were noted in all the alloys evaluated in this program. None of these were particularly detrimental in the normal application of these materials and, at most, would require only modest adjustment in hardware design. For the solid solution strengthened alloys Ta–10W and SNb-291 instabilities were confined to grain growth, whereas for the more advanced alloys responses were more complicated. The alloys with the highest creep strengths (T-111, T-222, and FS-85) demonstrated strikingly similar responses associated almost entirely with cored weld structure. These responses did not lend themselves to metallurgical analysis even under close scrutiny. D-43 displayed a classic overaging response ascribed to precipitation and subsequent coarsening of carbides while varying degrees of complexity in responses were displayed by the remaining alloy systems. In these latter systems responses were ascribed insofar as possible to previously identified mechanisms. Fracture mode differed markedly for the tantalum based alloys as compared with the niobium based alloys. Even though bend test results indicated a weld aging response in T-111 and T-222, bend test fractures occurred through ductile grain boundary tearing and did not represent a design limitation. In contrast, niobium alloys displayed an abrupt change from ductile to brittle behavior at the transition. These results reflect the same general observation of the weldability evaluation of these materials; based on ease of fabrication the niobium alloys appear to have been alloyed to the maximum extent possible, whereas current tantalum alloys are conservatively alloyed. (auth)

4941 (NASA-SP-245, pp 75-125) CREEP BEHAVIOR OF REFRACTORY ALLOYS IN ULTRAHIGH VACUUM. Sheffler, K. D.; Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

Several Nb, Ta, Mo, and W base alloys have been creep tested with both constant and continuously increasing loads in a vacuum environment of $<1 \times 10^{-8}$ torr at temperatures and stresses chosen to provide between $\frac{1}{2}$ and 1% creep in times up to 20,000 hours. Isostatic design data are presented in the form of a Larson–Miller plot for $\frac{1}{2}$ or 1% creep life for each of these refractory alloys. Elevated temperature tension test data from the tantalum base alloy T-111 showed a strain aging reaction in the 1400 to 2200°F range which produced an unusual transient creep behavior. Analysis of the isostatic steady state creep data for this material showed that the minimum creep rate can be described by the expression $\dot{\epsilon} = 1.65 \times 10^{9} [\sinh (6.6 \times 10^{-5} \sigma)]^{3.17} e^{-90,000/RT}$ in the temperature and stress ranges of 1600 to 2600°F and 500 to 45,000 psi. These values of activation energy and stress exponent suggest that the isostatic steady state creep of T-111 is governed by a diffusion controlled microcreep mechanism rather than by nonconservative dislocation motion. The creep tests which were run on T-111 alloy with continuously increasing loads provided continuously increasing creep rates which were comparable to the isostatic steady state creep rates at equivalent stress levels. Methods have been developed for prediction of the 1% creep life under varying stress conditions from isostatic creep test data, and comparison of these predictions with the experimental results shows the dependence of analytical techniques on the character of the isostatic creep curves. (auth)

4942 (NASA-SP-245, pp 127-42) EFFECT OF HEAT TREATMENT ON CREEP PROPERTIES OF THE TANTALUM BASE ALLOY ASTAR-811C. Harrod, D. L.; Buckman, R. W. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

ASTAR-811C has the nominal composition Ta–8W–1Re–0.7 Hf–0.025C and thus contains both solid solution and dispersed phase strengthening features. A study was initiated to investigate the response of ASTAR-811C to heat treatment and the associated changes in mechanical properties. Results of the first phase of this study are presented. Specimens were heat treated for times of 5 to 60 minutes at temperatures between 3000 and 3800°F, and their creep properties and microstructures were evaluated. (auth)

4943 (NASA-SP-245, pp 143-64) HIGH FREQUENCY FATIGUE PROPERTIES OF TZC AND T-111 ALLOYS. Steigerwald, E. A.; Sheffler, K. D.; Sawyer, J. C. (TRW Equipment Labs.). 1970.

From Conference on recent advances in refractory alloys for space power systems; Cleveland, Ohio (26 Jun 1969).

High frequency fatigue tests were conducted in an ultrahigh vacuum environment on recrystallized molybdenum base alloy TZC and tantalum base alloy T-111 at temperatures between 1800 and 2200°F. The results indicated that in this temperature range no well-defined endurance limit existed for either material. At A ratios of 0.45, fatigue strengths at 2000°F and 10^{9} cycles were as low as 16,000 psi for the TZC and 34,000 psi for the T-111. The application of a cyclic load to a statistically-loaded specimen produced a marked acceleration in the degree of specimen extension. In both the TZC and T-111 alloy the increase was characterized by a relatively rapid first stage creep extension (on the order of 1 to 10%) compared with the very small extensions (less than 0.01%) observed at the same temperatures and peak stresses in the isostatic creep tests. In the TZC alloy the dynamic loading increased the steady state creep rate by approximately two orders of magnitude; however, this acceleration was not observed for the T-111 alloy. Possible reasons for this behavior are discussed in terms of previous observations concerning the isostatic creep behavior of these materials. (auth)

4944 (ORNL–4770, pp 10-11) DIFFUSION IN SOLIDS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Volume self-diffusion coefficients have been determined for Fe–17 wt % Cr–12 wt % Ni by conventional and newly developed techniques to cover a wide temperature range, including the relatively low temperatures of usual engineering applications. Thermotransport in sodium and potassium chlorides is being studied theoretically and experimentally as steps in efforts to understand this phenomenon in ceramics. Radioactive ^{44}Ti is being used along with standard techniques to characterize diffusion rates and determine jump mechanisms in both rutile (TiO_2) and titanium monoxide (TiO_x) of varying stoichiometry. Research on atomic diffusion in refractory metals and alloys at high pressures and high temperatures is being initiated. (auth)

4945 (ORNL–4770, pp 22-5) PHYSICAL PROPERTY RESEARCH. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Emphasis on measurement technique improvements yielded accurate thermal conductivity, electrical resistivity, and specific heat capacity data in the range 1.2 to 2500°K on Mo, W, (Th,U)N, Ni_3Mn, and three alkali halides. These data were analyzed in terms of their electronic and lattice components. (auth)

4946 (ORNL–4770, pp 26-7) SUPERCONDUCTING MATERIALS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The fundamental superconducting properties of Mo–Re and Nb–Ir σ-phases were studied by low-temperature specific heat capacity measurements. The results were correlated with work on other σ-phases. The experimental technique for measuring superconducting critical current density was reexamined to take account of the influence of surface currents. Flux-pinning (critical current density, J_c) due to crystal defects was studied in several systems. These included Nb–10 at. % Ti, where the influence on J_c of grain size and dislocation distribution was examined, and Nb–Hf, where the influence of a Hf-rich precipitate on J_c was studied. Work on technetium and its alloys included studying superconductivity in Tc–Mo and Tc–Ti alloys and the preparation of high-purity technetium single crystals in cooperation with Argonne National Laboratory. (auth)

4947 (ORNL–4770, pp 109-14) METALLURGY OF REFRACTORY ALLOYS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

A base-technology program for high-temperature alloys which is principally concerned with tantalum-, niobium-, and molybdenum-base alloys is described. Alloy T-111 was more compatible than Ta with the nitrogen partial pressure over UN in the range 1200 to 1500°C, despite its hafnium content. This behavior has tentatively been attributed to the tungsten, which permits a greater equilibrium nitrogen pressure over T-111. A simple method for calculating the solubility limit of interstitial species in solid solutions from a single lattice parameter measurement was developed. The method is used to explain previously reported but apparently different solubility limits in two chemically similar alloys. Oxygen contents up to 3000 ppM had little effect on the tensile properties of T-111 if the doped specimens were heat treated before testing. However, as-doped specimens were completely brittle when contaminated to only 750 ppM. Apparently the form and distribution of the oxide precipitate has a greater effect than the oxygen content. Low nitrogen pressure moderately

strengthened T-111 in creep at 1400°C but reduced the rupture strain. Several experimental observations of spinoidal decomposition that cannot be explained satisfactorily were accounted for by considering free energy changes resulting from atomic clustering. Hot cracking involved liquid films in Mo and TZM welds. Both oxygen and carbon were detected on the surfaces of the cracks. Grain boundary porosity in the fusion and heat-affected zones also contributed to cracking. Fabrication of T-111 and Mo thermal-convection loops is reported. A crack in the Mo loop was successfully repaired by welding. The melting point of one brazing alloy was raised by volatilization of Cr and solution of Ta and that of another was slightly lowered by Be segregation. High-temperature thermal conductivity of T-111 estimated from low-temperature values and high-temperature electrical resistivity data was within 3% of measured values. Electrical resistivity was also used to estimate the high-temperature thermal conductivity of ThO_2-Mo cermets. Results of creep testing of tantalum alloys showed shorter rupture lives of welded than unwelded specimens at high stresses. Alloy SU-31 had the strongest stress-rupture properties of any Nb alloy yet tested. Initial examination of the T-111 forced convection loop that was operated with lithium for 3000 hr at a 1370°C heater exit temperature is reported. In static tantalum capsules at 600°C, increasing the oxygen concentration of the sodium led to increased dissolution of the tantalum in the sodium. When the concentration of oxygen in tantalum exceeded a threshold level, the sodium penetrated the tantalum. (auth)

4948 (SCL-DR-710069) ROOM TEMPERATURE CREEP BEHAVIOR OF WROUGHT AND AS-WELDED Ti-6Al-4V (STA). Odegard, B. C.; Maringer, R. E. (Sandia Labs., Albuquerque, N. Mex.). Nov 1971. Contract AT(29-1)-789. 22p, Dep. NTIS.

The room temperature creep behavior of wrought and as-welded Ti-6Al-4V was investigated at sustained stresses to 1000 hours. The creep behavior was typical of primary creep and could be expressed and thus predicted by established equations. Results showed that residual stresses imposed by the machining operation can influence the total creep strain exhibited at low applied stresses. For a given percent of yield, the as-welded specimens exhibited a greater resistance to creep strain. (auth)

4949 HARDNESS CHANGE OF Ag-Be ALLOYS BY INTERNAL OXIDATION. Kimata, Hidemi; Nishi, Seiki (Univ., Nagoya, Japan). J. Jap. Inst. Metals; 35: No. 6, 623-7(Jun 1971). (In Japanese).

Suitable heat treatment of Ag-Be alloys was studied for electrical contacts. To widen the hardening zone and increase the hardness of internally oxidized Ag-Be alloys, silver alloys containing 0.10, 0.20, 0.45, and 0.56 wt % Be were heated under various conditions. The optimum conditions of heat treatment were as follows: atmosphere of heat treatment: still air; cooling method of samples: oil quenching; heating temperature: 820°C; heating period: 4 hr. The suitable Be content was between 0.20 and 0.45 wt % Be. On heat treating by the optimum conditions, the maximum hardness of Ag-Be alloys was Hmv 118 for 0.20 wt % Be and Hmv 154 for 0.45 wt % Be. (auth)

4950 CARBON DIFFUSION IN ALLOYS OF NIOBIUM WITH TITANIUM AND ZIRCONIUM. Lyubimov, V. D.; Tskhay, V. A.; Bogomolov, G. D. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 44-7(1970). (In Russian).

C diffusion was studied in the range 800 to 1250°C for Nb-base alloys containing Ti 5.0, 15.1, 29.8, and 40.9 and Zr 5.0, 15.1, 24.2, and 36.1%. Radioactive ^{14}C was used and surface layers were successively removed and measurements made of the radioactivity. The following linear relations were established between log D_0 (diffusion coefficient), E (activation energy), and the alloying element concentration: for Nb-Ti $\log D_0^c = -19.03 - 0.099$ (% Ti) and $E^c = 10.1 - 0.179$ (% Ti) = $44.4 + 1.8 \log D_0$; for Nb-Zr $\log D_0^c = -17.9 - 0.138$ (% Zr) and $E^c = 12.3 + 0.112$ (% Zr) = $26.8 + 0.812 \log D_0$. The results are discussed in relation to the electronic structure of the alloys and the departure from the ideal structure caused by distortions of the lattice and macro-defects. (Referativnyi Zh.)

4951 RELATION BETWEEN RESIDUAL POLISHING AGENT AND MATERIAL HARDNESS DETERMINED BY A NARROW NUCLEAR-REACTION RESONANCE TECHNIQUE. Bernett, Marianne K.; Butler, J. W.; Wolicki, E. A.; Zisman, W. A. (Naval Research Lab., Washington, D. C.). J. Appl. Phys.; 42: No. 13, 5826-30(Dec 1971).

Clean smooth solid surfaces needed in certain investigations are often prepared with the aid of fine polishing powders, which may remain on the surface as residual contaminant. A study was made on the alumina and magnesia retentivity of twelve different metal surfaces as measured by a novel technique involving the use of strong sharp resonances in the nuclear reactions $^{27}Al(p,\gamma)^{28}Si$ and $^{26}Mg(p,\gamma)^{27}Al$. This technique has high sensitivity and, because of the sharpness of the resonances, also provides information on the penetration depths of the residual polishing agents as well as on the amounts present. A plot of the amount of residual polishing agent vs the hardness of the surface showed a general trend for the retentivity to be less with increase in solid hardness. Divergence from this trend was noted for metals which have other than cubic crystal structures; zinc and cadmium, two of the three softest metals, retained not only very small amounts of residue but also tended to keep this residue "at" the surface (little or no penetration of the base metal). The results are also discussed in relation to metal oxide formation and the adherence of such oxides to the metal. The nuclear-activation techniques and the conclusions should be applicable to all solid surfaces and to other surface-finishing procedures where the problem of residual or foreign material arises. In such cases, for each contaminant element present, a narrow-resonance nuclear reaction specific to that element would be used for the measurements. (auth)

4952 DETERMINATION OF ACTIVITIES AND REACTION RATES IN ALLOY MELTS BY MASS SPECTROMETRIC METHODS: Fe-V, Cu-Al, Fe-Si, Cu-Si AND Fe-S-O SYSTEMS. Weidner, Clarence Warren Jr. Columbus, Ohio; Ohio State Univ. (1971). 165p. University Microfilms Order No. 71-22,546. Thesis.

The thermodynamic properties of Fe-V and Cu-Al alloys have been determined by mass spectrometric measurements of the compositions of effusion fluxes from Knudsen cells containing the alloys. The alloy properties were calculated from the experimental measurements by ion current ratio integration techniques. An equation for the calculation of solution enthalpies across a liquid-solid field by the ion current ratio integration technique has been derived and applied to the Fe-V system. The temperature dependence of the liquidus and solidus boundaries had to be evaluated to make the calculations. Liquid and solid solutions of Fe-V alloys exhibit negative departure from ideal solution behavior at 1600°C. The excess integral free energy of mixing has a minimum of -1103 cal at $X_V = 0.40$. A method for determining the thermodynamic properties based on measurement of the pressure of an oxide reaction product has been developed and applied to measurements of the Al_2O intensity in the Cu-Al/Al_2O_3 system. Attempts to apply this method to SiO measurements in the Fe-Si/SiO_2 and Cu-Si/SiO_2 systems were unsuccessful because equilibrium was not established in the Knudsen cell. The thermodynamic properties calculated from the Al_2O and Al measurements are in good agreement and show that liquid solutions of Cu-Al alloys exhibit negative departures from ideal solution behavior at 1300°C. The solution enthalpy and excess integral free energy of mixing have minima of -3504 cal and -3263 cal, respectively, at $X_{Cu} = 0.60$. The excess entropy of mixing is positive which suggests the importance of electronic contributions to the thermodynamic properties and has a maximum of 0.65 e.u. at $X_{Cu} = 0.75$. Cu-Al alloys satisfy the conditions for "regular" behavior in the copper terminal solution region and the conditions for "subregular" behavior in the aluminum terminal solution region. The thermodynamic description of homogeneous bubble nucleation has been reconsidered to include the independent variance of embryo density and radius. The calculated Gibbs free energy surface has a saddle point $r^* = 2\sigma/p_e$, $p^* = p_e/e$ at which $G^* = (16/3)\pi e^2\sigma^3/p_e^2$. Homogeneous bubble nucleation is shown to be improbable in the absence of a very high level of solute supersaturation or extreme agitation. The experimental results in the Fe-S-O system, which cannot be explained by solute segregation alone, indicate that bubble nucleation is strongly induced by solidification. It is proposed that shrinkage upon solidification causes cavitation which results in bubble nucleation. These results show that the Knudsen cell mass spectrometer system can be used for studying the kinetics of metallurgical reactions. (Diss. Abstr. Int., B)

4953 EXPERIMENTAL STUDY OF THE ELASTIC PROPERTIES OF TWO-PHASE SOLIDS. Corson, Peter Burton. Philadelphia; Univ. of Pennsylvania (1971). 327p. University Microfilms Order No. 71-25,996. Thesis.

A study was made of the Young's modulus and shear modulus of three two-phase systems: aluminum-lead, iron-lead, and tungsten-lead. Statistically isotropic and homogeneous specimens were constructed at 20% volume-fraction intervals and 50% volume fractions by hot pressing mixtures of fine powders. Axial compression and torsion tests were performed on the specimens to determine the Young's modulus and shear modulus of such two-phase solids. The results were compared with the bounds of Hashin and Shtrikman and were found to lie within them. Other experimental studies of statistically isotropic and homogeneous two-phase systems were examined in relation to the Hashin-Shtrikman bounds and found to lie within them also. In addition, the Beran-Molyneux bounds on the bulk modulus and the McCoy bounds on the shear modulus of statistically isotropic and homogeneous two-phase systems were evaluated for the aluminum-

lead and iron–lead systems and compared with the Hashin–Shtrikman bounds. In these systems they were found to lie within the Hashin–Shtrikman bounds and to have significantly narrower bound widths than the Hashin–Shtrikman bounds. The McCoy bounds on the shear modulus were also compared with the experimental data from the iron–lead system. It was found that nearly all data lay superimposed on the lower bound. The evaluation of the Beran–Molyneux bounds and the McCoy bounds required a simplification of certain integrals appearing in those bounds and a knowledge of various spatial three-point correlation functions appearing in the integrals. The integrals in question were reduced from six-fold to three-fold integrations and derivatives in the integrands were eliminated by manipulation of the integrals. The integrals were reduced to the simplest forms possible without further knowledge of the particular forms of the included correlation functions. The various three-point correlation functions were measured experimentally for the aluminum–lead and iron–lead systems. This required the preparation of an ensemble of microphotographs of specimen cross-sections for each binary composition considered, statistical analysis of each ensemble of microphotographs to provide correlation-function values for a series of three-point configurations, and the construction of an empirical mathematical function to represent the set of correlation-function values. A technique of microphotograph analysis was developed which provided data in a form which could be used to generate information on higher-order and two-point, as well as three-point, correlation functions. The integrals in the Beran–Molyneux and McCoy bounds were then evaluated numerically using a computer, with the constructed empirical three-point correlation functions included in the integrands. (Diss. Abstr. Int., B)

4954 HIGH-SPEED (SUBSECOND) MEASUREMENT OF HEAT CAPACITY, ELECTRICAL RESISTIVITY, AND THERMAL RADIATION PROPERTIES OF TUNGSTEN IN THE RANGE 2000 TO 3600 K. Cezairliyan, A.; McClure, J. L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75A: No. 4, 283-90(Jul-Aug 1971).

Measurements of heat capacity, electrical resistivity, hemispherical total emittance, and normal spectral emittance of tungsten above 2000°K by a pulse heating technique are described. Duration of an individual experiment, in which the specimen is heated from room temperature to near its melting point, is less than one second. Temperature measurements are made with a photoelectric pyrometer. Experimental quantities are recorded with a digital data acquisition system, which has a full-scale signal resolution of one part in 8000. Time resolution of the entire system is 0.4 msec. Results on the above properties of tungsten in the range 2000 to 3600°K are reported and are compared with those in the literature. Estimated inaccuracy of measured properties in the above temperature range is: 2 to 3% for heat capacity, 1% for electrical resistivity, 3% for hemispherical total and normal spectral emittances. (auth)

4955 PLASTIC DEFORMATION OF Ti AND Zr. Brehm, C. (Compagnie Generale d'Electricite, Marcoussis, France); Lehr, P. Metaux (Corros.-Ind.); 46: No. 551-552, 253-71(Jul-Aug 1971). (In French).

The physical and mechanical characteristics of Ti and Zr are given together with their chemical analyses. The results of an investigation on the recovery and recrystallization of Ti and Zr, which had been work hardened by rolling, are presented. A method of preparing monocrystals of Ti was developed. The crystallographic aspects of the deformation of monocrystals of Ti by tensile testing at room temperature are presented. Monocrystals which had been plastically deformed by prismatic slip only, were also studied. Tensile test bar experiments were used to study the deformation of Ti and Zr. (France)

4956 PLASTICHESKAYA DEFORMATSIYA TUGOPLAVKIKH METALLOV I SPETSIAL'NYKH SPLAVOV. (Plastic Deformation of Refractory Metals and Special Alloys). Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). 264p.

Thirty-eight articles are included in the book. Separate abstracts were prepared for seven articles considered in the scope of NSA. (J.R.D.)

For abstracts of individual papers see: 4916, 4933, 4957–4959, 4976, and 4977.

4957 INVESTIGATION OF THE INFLUENCE OF RECRYSTALLIZATION ANNEALING ON THE PLASTICITY OF TYPE VA TUNGSTEN. Osipov, V. G.; Amosov, V. M.; Ushakov, E. V.; Drobysheva, E. K.; Zelentsova, N. M. pp 41-7 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

The plasticity of W bars prepared from larger bars by rotation forging using various procedures was studied. Compression tests were conducted at 400 to 1400°C. It was found that plasticity of forged W is largely controlled by the forging conditions. The greatest plasticity was found in bars formed at 1300 to 1450°C under normal pressing conditions. An increase above this temperature during forging and pressing decreases plasticity. Recrystallization and annealing of deformed bars leads to reduction of plasticity. After annealing the grain size in the bars was greater in large press specimens than in forgings of normal size. (tr-auth)

4958 INVESTIGATION OF THE RECRYSTALLIZATION OF METALLOCERAMIC TUNGSTEN. Gurevich, Ya. B.; Osipov, V. G.; Orzhekhovskii, V. L.; Ushakov, E. V.; Drobysheva, E. K. pp 48-51 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

Recrystallization of technical grade W rods was studied. A recrystallization diagram based on deformation data was constructed which showed that rolled specimens deform irregularly according to length. After annealing at various temperatures this irregularity leads to different grain sizes related to the rod cross section. The irregularity is also related to degrees of deformation. The critical degree of deformation was found to be 20 to 30%. The temperature for initiation of recrystallization was about 1200°C. (tr-auth)

4959 MECHANICAL PROPERTIES OF MOLYBDENUM ALLOYS Mo–C–Ti, Mo–C–Zr, AND Mo–Ti–Zr. Danil'chenko, A. N.; Falaleeva, Z. S. pp 75-9 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

The effects of alloying additions on the mechanical properties of deformed and recrystallized Mo at room temperature were examined. It was found that carbon affects the crystal lattice and is involved in solid solution decomposition. The Mo alloys are strengthened by the proper ratio between carbide-forming elements and carbon by producing dispersed phases which precipitate from solid solution. An optimum composition of Mo–C–Ti alloy was established having ductility and plasticity in crystallized state. (tr-auth)

4960 THERMOMECHANICAL PROPERTIES OF REAL MATERIALS: THE THERMAL EXPANSION OF UO_2 AND ThO_2. Winslow, George H. (Argonne National Lab., Ill.). High Temp. Sci.; 3: No. 5, 361-80(Sep 1971).

Evidence is cited to show that, when disagreement is found in experimental observations of the same property on nominally the same material, the possibility of actual sample difference should be considered before that of systematic errors in the measurement process. Such consideration is given to lattice parameter and bulk length measurements on various samples of UO_2 and ThO_2 with the conclusion that, were both types of measurement made on the same sample, Schottky defect development would be demonstrated for each material. Equations found for the defect density contain energies of 15.5-16.0 kcal/mole and preexponential factors not inconsistent with theoretical estimates. As part of the argument, it is shown that the results of direct lattice parameter measurements not specifically directed toward a study of sample differences are not superior to those which can be calculated from enthalpy measurements and room temperature values of the lattice parameter and adiabatic bulk modulus. From this it also follows that the parabolic expression in temperature to which lattice parameter measurements are commonly fit is inexact for these materials if any of the measurements lie in the range from room temperature to about 800°C. (auth)

4961 ACTIVITY AND RELATED THERMODYNAMIC PROPERTIES OF LEAD IN LIQUID INDIUM–LEAD ALLOYS. Shiu, D. H.; Munir, Z. A. (San Jose State Coll., Calif.). High Temp. Sci.; 3: No. 5, 381-8(Sep 1971).

The thermodynamic activity of lead in the liquid indium-lead system was determined in alloys ranging in composition from 10 to 90 at.% Pb. At 1070°K, these activities show positive deviations from ideality over the entire compositional range. From these activities, and from their dependence on temperature, partial molar and integral enthalpies, entropies and free energies were calculated for this system. Heats of mixing agree with those in the literature if $\Delta C_p \sim 0.25$ cal/deg mole. (auth)

4962 SURFACE SELF-DIFFUSION OF NIOBIUM IN AN ELECTRIC FIELD. Pautov, D. A. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 997-8(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1204-5(Apr 1971).

An electron field-emission microscope was used to study the surface self-diffusion of Nb in electric fields of both polarities. The formation of acute angles and edges in a Nb point increased the local field intensity at these places, and thus the voltage neces-

sary to produce 10^{-7} A emission current decreased with time. The activation energies of the surface self-diffusion was determined to fall in the range 1.2 to 3.0 eV for fields of (1.1 to 3.5×10^7 V/cm). The process was faster in a negative field. (D.L.C.)

Structure and Phase Studies

4963 (COO-588-25) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM-NIOBIUM AND OTHER ALLOYS. Final Report. Hehemann, R. F. (Case Western Reserve Univ., Cleveland, Ohio. Div. of Metallurgy and Materials Science). 1 Nov 1971. Contract AT(11-1)-588. 13p. Dep. NTIS.

The principal results of an investigation on transformations in zirconium and other alloys conducted during the period from November 1957 to October 1971 are summarized. The principal focus of the work has been concerned with the characterization and evaluation of some of the more important metastable states encountered in the bcc transition metals. The zirconium–niobium system was chosen not only because this system is ideally suited for this purpose but also because of its interest in nuclear reactor and superconductor applications. For generalization of some of the principal results, the equiatomic intermediate phase in the TiNi system was also examined. The latter alloy is of special interest for a variety of applications because of its well known shape-memory behavior. (auth)

4964 (ORNL-4770, pp 7-9) DEFORMATION OF CRYSTALLINE SOLIDS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Anisotropic elasticity calculations were made for nonbasal dislocations in hexagonal metals, for dislocation displacements, and for the interaction of dislocations with point defects. Work on precipitation in the Nb-Hf system is continuing. Simulation of solid solutions with respect to short-range order and displacement effects is also being studied. (auth)

4965 (ORNL-4770, pp 20-1) FUNDAMENTAL PHYSICAL METALLURGY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Hillert's theory of normal grain growth was extended to include solute impurity effects and the effect of specimen thickness. Rolling and recrystallization textures of a metastable bcc uranium alloy were determined. Partial correlation functions were derived for vacancy diffusion in body-centered tetragonal lattices. Auger electron spectra for each element have been calculated and cataloged. (auth)

4966 (ORNL-4770, pp 186-94) METALLOGRAPHY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The usefulness of electron microprobes in metallographic studies is noted. Demands on low detection limits have been met by long counting times (100 sec) and a stable electron beam. In one examination, two or three monolayers of La_2O_3 deposited on NaCl have been analyzed. Beam scanning capabilities for elemental characterization have proven to be a useful, informative, economical approach for analyses with the model 400S microprobe. The alpha metallography facility was moved from Building 3019 to 4508, and minor improvements deemed necessary through operating experience were made. Efforts to better understand and identify the microconstituents of δ-ferrite, σ-phase, and carbide in welds by chemical etching, autoradiography, and magnetic etching gave good results. Additional information was published on the proper use of xenon illumination systems on metallographs. A new recording approach was audio-video taping of the extensive disassembly and investigation of a steam generator. The Quantitative Image Analyzer was improved and equipment for measuring anisotropy characteristics with polarized light is being developed. (auth)

4967 QUANTITATIVE ANALYSIS BY EPMA FOR THE CONCENTRATION OF ALLOYING ELEMENTS IN THE MICRON-AREA OF TITANIUM ALLOYS. Tokuda, Shoichi; Kawahara, Hiromichi (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 35: No. 6, 541-7(Jun 1971). (In Japanese).

In an attempt to quantitatively clarify microsegregation in the abnormal microstructure formed in some titanium alloys, studies were made on the working curves for Al, Fe, Cr, Mo, and V in titanium alloys using electron probe microanalysis (EPMA). The accuracy of the analysis using the working curves and the possible minimum size of area for micro-area-analysis were also examined. Working curves were obtained in the form of a quadratic or linear equation for each alloying element which was less than 20 wt % in content, using 43 kinds of standard specimens of titanium and titanium alloys. The distribution rate which was obtained from the regression analysis was more than 99% for each working curve, the error of the working curves being within the range of 0.09–0.38 wt %. In the quantitative analysis of Ti–Fe binary alloys, the measured Fe concentrations of the α and β phases were compared with those of the α and β phases which were easily assumed from the Ti–Fe binary equilibrium diagram, and the results showed good agreement. It was also found that an area of 3 μ^2 would be sufficient to measure the concentration in the micro-area quantitative analysis. The quantitative analysis of concentrations in a micro-area, namely the microsegregation analysis of the abnormal microstructures of titanium binary and multiple alloy systems proved to have great possibilities for use of the working curve method with EPMA. (auth)

4968 EFFECTS OF SOLUTE ELEMENTS ON THE MORPHOLOGY OF ω PHASE IN THE BINARY $\alpha + \beta$ TITANIUM ALLOYS AND THE METASTABLE β TITANIUM ALLOYS. Ikawa, Hiroshi (Osaka Univ., Suita, Japan); Shin, Shigeo; Miyagi, Masakazu; Morikawa, Masaki. J. Jap. Inst. Metals; 35: No. 6, 628-32(Jun 1971). (In Japanese).

The morphology of the ω phase in β-eutectoid titanium alloys (Ti–Mn, Ti–Fe, Ti–Cr, Ti–Co, Ti–W, Ti–Ni) and β-solid solution titanium alloys (Ti–Mo, Ti–Ta, Ti–V) was investigated by transmission electron microscopy. Considering the standard of atomic size, the morphology of the ω phase in titanium alloys can be classified into cubic and ellipsoidal types. The ellipsoidal type ω phase was observed in the titanium alloys with alloying elements of atomic sizes larger than that of V, and the cubic type ω phase was observed in the titanium alloys with alloying elements of atomic sizes smaller than that of V. Besides, the crystal structure of both ω phases was the same hexagonal structure. (auth)

4969 INTERNAL OXIDATION OF NIOBIUM–ZIRCONIUM–TITANIUM ALLOYS. Tsirlin, M. S. Zashch. Metal.; 5: No. 6, 682-4(1969). (In Russian).

A study was made of the structure of the zone of internal oxidation in eight Nb–Zr–Ti triple alloys, oxidized in dry O_2 at 550 to 1000° and 740 mm pressure. The presence of characteristic striated structures was established. The formation of such structures is associated with perlite-like decomposition of supersaturated solid solutions of O_2 in alloys with formation of O_2-rich α-phase and β-phase less rich in O_2. (Referativnyi Zh.)

4970 EFFECT OF OXYGEN ON THE ELECTRICAL AND STRUCTURAL PROPERTIES OF TRIODE-SPUTTERED TANTALUM FILMS. Waterhouse, Neil; Wilcox, Philip S.; Willmott, David J. (Bell-Northern Research, Ottawa). J. Appl. Phys.; 42: No. 13, 5649-53(Dec 1971).

The structural and electrical properties of oxygen-doped tantalum films, sputtered in a triode system, have been investigated. X-ray diffraction traces from films with a low oxygen content indicate the presence of bcc Ta with a strained lattice. The intensity of the (110) bcc Ta diffraction peak decreases with increasing oxygen content and is interpreted as a decrease in the amount of bcc Ta phase present. Over this same range the appearance and rise in intensity of the β-Ta (200) peak indicates the formation of β-Ta. As the oxygen content is further increased, the structural data indicate a reorientation of the tetragonal β-Ta (200) to the (202) planes with respect to the film surface, an effect which has been previously observed in diode-sputtered tantalum; further increase in oxygen content produces a stretching of the β-Ta lattice by as much as 10% of the value reported by Read and Altman. The room-temperature resistivity increases with increasing oxygen content until a "plateau" region is reached at ~210 $\mu\Omega$ cm corresponding to 12 at. % oxygen, and together with the x-ray data the electrical measurements indicate a change of phase from bcc to β-Ta. Above approximately 40 at. % oxygen, the resistivity increases rapidly suggesting the formation of tantalum oxide. (auth)

4971 STUDY OF THE PHASE TRANSFORMATIONS IN THE METASTABLE BETA TITANIUM ALLOYS, Ti–13V–11Cr–3Al, Ti–13V–11Cr, AND Ti–15Cr AND THE MICROSTRUCTURAL-MECHANICAL PROPERTIES RELATIONSHIP IN THE Ti–13V–11Cr–3Al ALLOY. Narayanan, Gangadharan Hari. Seattle; Univ. of Washington (1971). 328p. University Microfilms Order No. 71-24,066.

Thesis.

The phase transformations which occur in the all-beta titanium alloy Ti–13V–11Cr–3Al in the temperature range 250 to 700°C have been investigated using thin foil transmission electron microscopy as the principal technique. The electron microscopy results have been supplemented by x-ray diffraction analysis, electrical resistivity, and hardness measurements. The decomposition characteristics of the metastable beta phase in the Ti–13V–11Cr–3Al alloy have been compared with those in the Ti–13V–11Cr and Ti–15Cr alloys in order to establish the influence

of the alloying additions on the transformation behavior. A spontaneous shear transformation occurs in the metastable beta phase of all three alloys, during thin foil preparation by electropolishing. The product of the transformation in most cases has been identified to be a distorted fcc phase. The initial decomposition of the metastable beta phase in the Ti–13V–11Cr–3Al and Ti–13V–11Cr alloys, during aging at temperatures below 500°C, proceeds through a phase separation reaction involving the homogeneous precipitation of a coherent, solute lean bcc phase, β_2. The omega phase formation is completely suppressed in these alloys. The influence of the heat treatment variables on the size and distribution of the β_2-precipitates has been examined to determine the role of excess vacancies on the nucleation of this phase. In the case of the Ti–15Cr alloy, in which the ω-phase forms during aging at temperatures below ~450°C, a phase separation reaction has been detected in the beta phase prior to the precipitation of both the omega and the equilibrium α-phases. This reaction becomes a prominent mode of decomposition when the omega precipitation is inhibited by direct quenches to a temperature just above 450°C or when a specimen, initially aged at a lower temperature to a large volume fraction of the ω-phase, is up-quenched to a temperature above 450°C. The observed phase separation reaction is a transition reaction and the $\beta_1 + \beta_2$ structure is metastable with respect to the $\beta + \alpha$ structure in the Ti–13V–11Cr–3Al and Ti–13V–11Cr alloys and the $\beta + \omega$ and the $\beta + \alpha$ structures in the Ti–15Cr alloy. Continued aging of these alloys results in the formation of the α-phase having a plate-shaped morphology and the observations indicate that this α nucleates within the solute-lean β_2-precipitates. Prolonged aging at the same temperature yields needle-shaped α-precipitates which exhibit a Widmanstätten morphology. At aging temperatures above 500°C, the α-precipitation occurs predominantly by heterogeneous nucleation at the beta grain boundaries and other lattice discontinuities. Deformation prior to aging has been found to accelerate the precipitation of the α-phase at all temperatures. The precipitation of the intermetallic compound $TiCr_2$ in the Ti–13V–11Cr–3Al alloy has been examined and the orientation relationship between the beta matrix and $TiCr_2$ has been established. The kinetics of all the transformations which occur in the Ti–13V–11Cr–3Al alloy in the temperature range of 300 to 700°C have been summarized by a time-temperature-transformation diagram. A comparison of the decomposition characteristics of the metastable beta phase in the Ti–13V–11Cr–3Al, Ti–13V–11Cr and Ti–15Cr alloys has been made to establish the influence of the alloying additions on the various transformations observed. An interpretation of the observed decomposition sequence, based on thermodynamic reasoning, is presented. The mechanical properties of the alloy, Ti–13V–11Cr–3Al, have been investigated for a wide range of the heat treatment conditions in order to obtain a direct correlation between the resulting microstructures and the mechanical properties. The precipitation of β_2 does not lead to a significant improvement in the tensile strength characteristics while appreciable increases in yield stress and ultimate tensile strength have been observed in alloys heat treated to produce the α-phase. The increase in tensile strength is accompanied by a reduction in ductility. A small degree of softening and considerable embrittlement have been observed with the precipitation of $TiCr_2$. The deformation substructures observed in the beta phase consist of a high density of dislocations confined to well-defined deformation bands, unlike those observed in other bcc metals which exhibit a high density of tangled dislocations and the characteristic dislocation cell structures. The α-precipitates have been found to act as effective barrier to the propagation of the slip bands. The Ti–13V–11–Cr–3Al alloy, in the all-beta condition has been found to exhibit mechanical effects associated with the phenomenon of dynamic strain aging. Well defined yield points have been observed on reloading a specimen, following a load interruption in the plastic strain region and also when the strain rate is abruptly increased. The magnitude of this yield drop has been studied as a function of total plastic strain, time and temperature of relaxation as well as the ratio of the final to the initial strain rate. (Diss. Abstr. Int., B)

4972 ORDERING THE Ni-RICH ALLOYS OF THE Ni–Nb AND Ni–Ta SYSTEMS. Van der Wekken, Cornelis Jan. Seattle; Univ. of Washington (1971). 156p. University Microfilms Order No. 71-24,088.

Thesis.

A new type of long-range ordering reaction leading to the formation of a previously unreported structure has been discovered in Ni-rich Ni–Nb binary alloys. This LRO reaction occurs during the aging of supersaturated Ni–Nb solutions containing from 7 to 12 at. % Nb at temperatures between approximately 275 and 500°C. On the basis of data from electron microscopy and selected area electron diffraction the structure of the LRO phase has been determined as fct with $a = b \simeq 3a_0$ and $c \simeq a_0$, where a_0 is the lattice parameter of the parent solid solution. The stoichiometric composition of the LRO is Ni_8Nb. The close-packed layers of the Ni_8Nb structure show triangular ordering in which the niobium atoms are separated by two nickel atoms along close packed directions. This formation of a long-range ordered phase occurs by the nucleation and growth or ordered domains, for which three mutually perpendicular orientations or variants are possible. The c-axis of the ordered fct unit cell is parallel to one of the ⟨100⟩ directions of the fcc matrix. Electrical resistivity measurements were used to investigate short-range ordering as well as the formation of long-range order in Ni-rich Ni–Nb alloys. It was observed in Ni-rich Ni–Nb alloys containing from 3.1 to 10.3 at. % Nb that the changes in the electrical resistivity due to short-range ordering exhibit an anomalous dependence on the solute concentration. In the vicinity of the Ni_8Nb composition and near or below the critical temperature for LRO, the electrical resistivity decreases with increasing SRO, while a positive contribution to the resistivity is made by the SRO in alloys of lower niobium concentration. This anomaly has been explained in terms of the formation of embryos of LRO of the type Ni_8Nb in alloys approaching the Ni_8Nb composition and near or below the critical temperature of LRO. The nucleation of domains of LRO of the type Ni_8Nb requires the presence of a critical excess vacancy concentration prior to aging, unless aging times of the order of several months are applied. This requirement has been interpreted in terms of a large critical size of the nuclei for the long-range ordered domains. The critical temperature for stoichiometric Ni_8Nb is 540°C. The Ni_8Nb long-range ordering reaction exhibits C-curve behavior, the maximum reaction rate in quenched alloys occurring at aging temperatures of about 400°C. The effective activation energy for the long-range ordering reaction in quenched alloys has been determined for different alloy compositions. It was found that the activation energy for the stoichiometric composition of Ni_8Nb is 1.45 ± 0.1 eV, which is close to the migration energy reported for vacancies in pure nickel. It is concluded that quenched-in vacancies can account for the experimentally observed values of the activation energy. The activation energy for the long-range ordering process was found to decrease slightly with decreasing niobium content of the alloys, which is consistent with the experimental observation that the long-range ordering reaction is faster in alloys, somewhat lower in Nb content than the stoichiometric alloy. The characteristic superdislocations in ordered Ni_8Nb and Ni_8Ta, both of which have the same structure, are composed of three dislocations with a/2 ⟨110⟩ Burgers vectors in either a symmetric or in an asymmetric configuration. For stoichiometric Ni_8Ta the antiphase boundary energies of the areas between the dislocations were calculated from the distance between the dislocations. The APB energies have been related to the change in the number of the different atom pairs which is associated with the introduction of the dislocations into the ordered material. Atomic pair interaction energy terms were calculated from the values of the APB energies. The existence of the ordered Ni_8X structure can be accounted for on the basis of the values of the first through the fifth nearest neighbor atomic pair interaction energy terms. Cowley's ordering theory has been adapted for the long-range order of the type Ni_8X. The theoretical value of the critical temperature of stoichiometric Ni_8Ta, based on Cowley's ordering model and on the experimental values of the atomic pair interaction energy terms, is within 12% of the experimental value of T_c. It was found that stoichiometric Ni_8Nb and Ni_8Ta have critical temperatures of 540°C and 568°C respectively. The electrical resistivity of ordered Ni_8Nb and Ni_8Ta as a function of the ordering temperature shows a discontinuity at the critical temperature, which is in agreement with theoretical predictions of a first order transformation at the critical temperature for the long-range order or the type Ni_8X. This investigation has also included a study of the composition and the temperature range over which LRO of the type Ni_8Nb occurs. On the basis of a comparison of the experimental data with the equilibrium phase diagram for the Ni–Nb system, it was concluded that the long-range ordered Ni_8Nb phase is metastable. (Diss. Abstr. Int., B)

4973 MARTENSITIC TRANSFORMATION IN ZIRCONIUM–NIOBIUM ALLOYS. Banerjee, S.; Krishnan, R. (Bhabha Atomic Research Centre, Trombay, India). Acta Met.; 19: No. 12, 1317-26(Dec 1971).

Two types of martensite morphologies have been obtained in zirconium and zirconium–niobium alloys containing up to 5.5 wt % niobium. The massive martensite of pure zirconium and alloys containing less than 0.8 wt % niobium, showed twin free martensite plates whereas the acicular martensite plates were internally twinned predominantly on $\{10\bar{1}1\}$ planes. Other inhomogeneous shear systems like $\{10\bar{1}1\}\langle\bar{1}123\rangle$ slip and $\{11\bar{2}2\}\langle\bar{1}\bar{1}23\rangle$ twin have also been found to be operative. Evidences for additional inhomogeneous shear inside thick twin bands have also been found. Simultaneous occurrence of both $(\bar{2}112)$ twinning and $(\bar{1}101)$ slip along the common direction $[2\bar{1}\bar{1}3]$ provided another example of multiple

shear inhomogeneous deformation. The habit plane determinations of these alloys indicated that the $\{334\}_\beta$ habit, already reported for pure zirconium, remained unaltered with the addition of niobium. This was to be expected because the principal lattice strains did not change appreciably with niobium addition. (auth)

4974 DEFECT STRUCTURE OF DEPLETED ZONES IN IRRADIATED TUNGSTEN. Beavan, L. A.; Scanlan, R. M.; Seidman, D. N. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3504-50. Acta Met.; 19: No. 12, 1339-50(Dec 1971).

A quantitative field ion microscope study was made of the defect structure of two depleted zones detected in high purity ($\leq 1.5 \cdot 10^{-6}$ at.fr. impurity level) tungsten specimens irradiated in situ under ultra-high vacuum conditions at a specimen temperature of 18°K with 20 keV W^+ ions to a dose of $\sim 1.10^{12}$ W^+ ions cm^{-2}. The irradiated specimens were examined by the pulse field evaporation technique at 18°K, hence their structure was characteristic of this temperature. The depleted zone detected in the (111) plane had a local vacant site concentration of ~8.7 at. % and a self-interstitial atom concentration (SIA) of ~0.92 at. %, while the depleted zone detected in the (141) plane of a second specimen had values of ~10 and ~0.5 at. % for these same quantities. The SIAs found locally were on the peripheral surfaces of the depleted zones. In addition to this large local imbalance in point defect concentrations the depleted zones were elongated along ⟨011⟩ directions. It was found that each of these depleted zones was created by a single incident ion, and a comparison of the number of displaced atoms in each zone with the value predicted by the Kinchin–Pease model showed that this model strongly overestimates the number of displacements created per incident ion. For the depleted zone detected in the (111) plane, it was demonstrated that 23 of 25 SIAs found in the lattice around this zone could have been propagated away from it along ⟨011⟩ and ⟨111⟩ directions as focused replacement sequences. The measured distances of these SIAs away from the depleted zone along ⟨011⟩ and ⟨111⟩ directions were between 45 to 150 and 45 to 85 Å, respectively. The upper and lower values of these distances were determined by a geometric sampling problem and not by the intrinsic range of focused replacement sequences. (auth)

4975 PRECIPITATION-HARDENING CHARACTERISTICS OF TERNARY COBALT–ALUMINUM–X ALLOYS. Lee, Charles Samuel. Tucson, Ariz.; Univ. of Arizona (1971). 169p. University Microfilms Order No. 71-24,368.

Thesis.

Five precipitation-hardenable ternary cobalt-base alloy systems containing 4.25 weight percent aluminum with titanium, niobium, tantalum, molybdenum, and tungsten as the third element were melted and evaluated as to their precipitation-hardening characteristics. Hardening phases were electrolytically extracted from alloys aged up to 1000 hours in the 600 to 900°C temperature range. Based upon the evaluation of these systems, three quaternary alloys with compositions Co–4Al–15Cr–10Ta, Co–4Al–15Cr–20Mo, and Co–4Al–15Cr–25W were melted and similarly evaluated after aging for times from 0.1 to 1000 hours at 800°C. The results of the investigation of the ternary alloys showed that Ti additions promoted the highest percentage increase in hardness, but that overaging of the $AlCo_2Ti$ hardening phase was very rapid. The effects of the Nb and Ta additions to the Co–4Al matrix were somewhat similar in that both were considerably more effective as solid solution strengtheners than as precipitation hardening agents. Hardening in the Ta alloys was the result of the presence of primary and precipitated γCo_2Ta ($MgNi_2$ type) which, upon aging, transformed to the cubic αCo_3Ta. Similarly, in the alloys containing Nb, the Laves phase Co_2Nb ($MgNi_2$ type) was generally present. Two phases previously reported in the literature for the Co–Nb binary system were confirmed. The Co–4Al–5Nb alloy aged for 1000 hours at 700°C contained an ordered fcc phase with $a_0 = 3.655$ Å, while this same alloy aged at 800°C contained a hexagonal phase having the parameters a = 5.94 Å and c = 6.89 Å. The cellular precipitation of Co_3Mo in the Co–Al–Mo alloys produced very high hardnesses in that alloy system. Temperatures of 900°C were required to overage these structures within the 1000-hour test interval. In the Co–Al–W systems, an ordered fcc superlattice, or coherent precipitate, having a parameter of $a_0 = 3.595$ Å was found. Precipitation of this phase resulted in continuous increases in hardness for aging times up to 1000 hours at 800°C. Additions of 15 weight percent Cr to the basic Co–4Al–10Ta, Co–4Al–20Mo, and Co–4Al–25W alloys changed their aging behavior; and in the case of the latter two alloys, the R and Mu phases, respectively, appeared. Aluminum additions to alloys of Co containing the refractory metals or Ti generally result in a stabilization of the fcc Co matrix and a resulting decrease in the tendency for the formation of non-cubic phases in the matrix. This effect seemed especially strong in the alloys containing Ta and W where the formation of rhombohedral βCo_3Ta and hexagonal Co_3W were suppressed. Chromium additions to the ternaries containing Al tended to destabilize the fcc matrix and promoted the formation of non-cubic phases. (Diss. Abstr. Int., B)

4976 CRITICAL TRANSITION TEMPERATURE OF MOLYBDENUM UPON DEFORMATION BY DEEP DRAWING. Osipov, V. G.; Mutovin, V. D.; Egorov, B. V. pp 71-5 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

Relations of critical temperature of ductile-to-brittle transition with the microstructure of metalloceramic and vacuum-worked Mo were studied. Resulting data are used to establish the lower temperature limit for deformation in an experimental specimen subjected to deep drawing. Drawing dies were used which were designed for operation at +180 to –180°C. Values for drawing coefficients of recrystallized and fibrous specimens were estimated using critical temperature of transition data. (tr-auth)

4977 RECRYSTALLIZATION OF MOLYBDENUM ALLOYS AS A FUNCTION OF COMPOSITION AND ANNEALING TEMPERATURE. Falaleeva, Z. S.; Danil'chenko, A. N. pp 80-6 of Plasticheskaya Deformatsiya Tugoplavkikh Metallov i Spetsial'nykh Splavov. /Pavlov, I. M. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

The effects of additions of carbon titanium and zirconium on recrystallization and crystal structure of fine-grained Mo were studied. Specimens in the form of bars and ribbons were used to show the effects of secondary phases on the characteristic microstructure resulting from annealing. Resulting data were used to establish a select Mo-base alloy for production of ribbon having improved recrystallization temperatures. (tr-auth)

4978 ELECTRON MICROSCOPE STUDY OF PRECIPITATES IN A Zr-2.5 PERCENT Nb ALLOY. Ogawa, Yutaka; Katano, Yoshio; Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokai). J. Jap. Inst. Metals; 35: No. 6, 593-8(Jun 1971). (In Japanese).

A transmission electron microscope study was carried out on a Zr–2.5% Nb alloy water-quenched from 1000°C and subsequently aged at 400, 500, and 580°C. After aging for 50 hr at 500°C, the precipitates exerted a strain field on the surrounding matrix in the direction nearly perpendicular to the prismatic plane, whereas in the direction approximately perpendicular to the basal plane, the precipitates formed the Windmanstaetten structure without strain field in the matrix. The strain field did not disappear until 1000 hr at 500°C, so the precipitate was thought to correspond to the intermediate phase of β-niobium. The precipitates were thought to be in the form of thin platelets lying on $\{10\bar{1}\,n\}$ planes (n is large and the planes nearly correspond to the {0001} plane) and growing approximately along $\langle 1\bar{2}10\rangle$ directions in the matrix. The mean length of the precipitates was 820 Å after aging for 1000 hr at 500°C and 700 Å after aging for 10 hr at 580°C. (auth)

Radiation Effects

Refer also to abstracts 5600 and 6242.

4979 (ORNL–4770, pp 12-17) ELECTRON MICROSCOPY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Effects of material and irradiation variables on the damage produced in metals by neutron and electron irradiation are described. Features of the annealing of voids in irradiated aluminum and the development of porosity in carbonyl nickel by heat treatment are reported. A program for evaluating the mechanisms involved in void formation during neutron irradiation is summarized, and a theoretical description of vacancies in ternary alloys is given. The defect structure of boron carbide is described, and a discussion of dislocations in the double helix structure is presented. Hardness–grain size relationships in α-brass and iron are reported. Recent measurements of the energy stored during plastic deformation are presented and related to current work hardening theories. The effects of composition on the aging characteristics of Hastelloy N are described. (auth)

4980 (ORNL–4770, pp 69-77) CLADDING AND STRUCTURAL MATERIALS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Irradiation of austenitic stainless steels at temperatures between 350 and about 650°C to fast neutron fluences in excess of 1×10^{21} neutrons/cm^2 creates voids and dislocations. This damage increases volume and also degrades the mechanical proper-

ties, particularly the ductility. The irradiation-induced property changes in standard types 304 and 316 stainless steel (cladding and structural materials for FFTF and demonstration plants) are being defined as a function of temperature and neutron fluence. A decrease of the property changes through control of alloy composition and microstructure is being studied. The radiation-induced volume change in types 304, 316, and titanium-modified 316 stainless steel can be significantly reduced by cold working to introduce a high dislocation density before irradiation. Further, titanium-modified types 304 and 316 stainless steel, which were developed for resistance to radiation embrittlement above about 650°C, also exhibit higher postirradiation ductilities in the range 500 to 600°C. Thus, in the modified alloys cold work can be utilized to control the swelling without a drastic reduction in ductility. (auth)

4981 (ORNL-4770, pp 131-5) MECHANICAL PROPERTIES OF IRRADIATED METALS AND ALLOYS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Nickel 270 (99.98% nominal purity) was irradiated in EBR-II to fluences ranging from 1.0×10^{18} to 1.5×10^{22} neutrons/cm^2 over the range 375 to 525°C. Voids were formed over the entire range of conditions and were inhomogeneously distributed at the lower fluences. Samples of Mo, Mo–0.5% Ti, Mo–50% Re, Ta, Nb, V, and V–20% Ti were irradiated in EBR-II at various temperatures to fluences up to 3×10^{22} neutrons/cm^2. The microstructure was studied using a newly developed remote thinning technique for the Ta. Tensile tests were run on the Mo-base alloys, and the DBTT was raised markedly. The types of damage that occur in 1100, 8001, and 6061 aluminum-base alloys have been characterized. Alloy 6061 shows considerably less swelling than the other alloys. This is attributed to the fine Mg_2Si precipitate in the 6061 alloy, whereas the others are basically solid solution alloys. (auth)

4982 (ORNL-4770, pp 149-55) HEAVY SECTION STEEL TECHNOLOGY. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Previous observations that the Charpy V-notch properties but not the tensile properties are affected by the anisotropy of 12-in.-thick plate were substantiated. Electroslag weld metal was less sensitive to irradiation than submerged-arc welds in Charpy V-notch studies. This difference, however, is compensated for by the superior toughness of the submerged-arc weld in the unirradiated condition. A technique was developed for generating sharp fatigue-like cracks for use in the intermediate test vessels and allied tests. Cracks are induced using hydrogen in a confined martensitic region with residual stresses. The 6-in.-thick ASTM A508 class 2 steel shell sections of the 39-in.-dia intermediate test vessel were tempered at 1270°F following a water quench. The tensile properties of this material were excessive; means to reduce the strength were sought by heat treatment studies and metallography. A 1320°F retemper was selected to obtain mechanical properties within typical ranges for this grade of steel. (auth)

4983 (ORNL-4770, pp 157-70) MOLTEN-SALT REACTOR PROGRAM. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Several components from the MSRE have been examined. The only problem noted was intergranular cracking of the Hastelloy N to a depth of about 0.005 in. Laboratory melts of modified Hastelloy N containing Ti, Nb, and Hf were prepared with acceptable resistance to irradiation embrittlement. Small commercial melts with Ti additions had properties similar to those of the laboratory melts, but the alloys with Hf additions were not as good. Hastelloy N showed excellent resistance to corrosion by fluoride salts of the $LiF-BeF_2$ base. The material corrodes more rapidly in $NaBF_4$–8 mole % NaF, and the corrosion seems to be controlled by the presence of oxidizing impurities. Results of tests in steam show a very low corrosion rate for unstressed Hastelloy N. Fabrication and joining techniques were developed for a molybdenum test stand for reductive-extraction chemical processing studies. Back-extrusion was developed for fabricating 3$^7/_8$-in.-OD containers up to 4 in. long. Electron-beam and tungsten-arc welding parameters were determined for tube-to-tube, tube-to-header, and header-to-header joints. Iron-base brazing alloys were formulated and tested for wettability, flowability, strength, and compatibility with bismuth and molten salts. Compatibility studies of molybdenum, TZM, tantalum, T-111, and graphite were continued at 650 to 700°C in pure bismuth and Bi-Li solutions; molybdenum, TZM, T-111, and graphite appear very promising. Studies of methods of putting adherent coatings of W and Mo on Ni- and Fe-base alloys were continued, and coatings were tested by exposure to bismuth. (auth)

4984 NEUTRON IRRADIATION DAMAGE IN MOLYBDENUM. PART IV. A QUANTITATIVE CORRELATION BETWEEN IRRADIATED AND IRRADIATED-ANNEALED STRUCTURES. Maher, D. M.; Eyre, B. L.; Bartlett, A. F. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 24: No. 190, 745-65(Oct 1971).

Molybdenum single crystals ($7000 \leq \rho_{293°K}/\rho_{4.2°K} \leq 8000$) were irradiated to a dose of $\sim 7 \times 10^{19}$ fission n cm^{-2} at 473°K and defect structures were investigated by electron transmission microscopy prior to and after a post-irradiation anneal of one hour at 1173°K. A quantitative and geometrical characterization was carried out on small defect clusters (20 Å ≤ image diameter ≤ 100 Å) in an irradiated crystal and on resolved dislocation loops (100 ≤ image diameter ≤ 1100 Å) in an irradiated-annealed crystal. These two structural states were related in terms of both the nature and the density of visible defects. The irradiated structure was also compared in these terms with molybdenum crystals of the same purity damaged at 77°K to doses of $\sim 1 \times 10^{20}$ and $\sim 5 \times 10^{17}$ fission n cm^{-2}. (auth)

4985 NEUTRON IRRADIATION DAMAGE IN MOLYBDENUM. PART V. MECHANISMS OF VACANCY AND INTERSTITIAL LOOP GROWTH DURING POST-IRRADIATION ANNEALING. Eyre, B. L.; Maher, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 24: No. 190, 767-97(Oct 1971).

An electron microscope study was made of the time-dependent annealing behavior of interstitial loops in impure and pure molybdenum neutron irradiated at 77°K (A_{77} and C_{77}, respectively and of vacancy loops in pure molybdenum neutron irradiated at 473°K (C_{473}). The results were quantitatively analyzed and loop growth behavior was compared with that predicted theoretically for perfect loops growing by bulk vacancy-limited diffusion mechanism and by a glide and self-climb mechanism. It was found that the interstitial loop growth observed in A_{77} and C_{77} is accounted for by a glide and self-climb mechanism. On the other hand, vacancy loop growth observed in C_{473} can be accounted for by a bulk vacancy diffusion mechanism although it is considered that both mechanisms contribute to the observed growth at intermediate stages of the anneal. Finally, two general distinguishing features of loop growth were exposed. Firstly, under bulk vacancy diffusion-limiting conditions, interstitial loops were considerably more stable than vacancy loops whereas the glide and self-climb mechanism made no distinction between loop nature. Secondly, with regard to the growth kinetics, bulk diffusion-limited growth was approximately linearly dependent on time t, whereas growth by glide and climb should follow a $t^2/13$ law. (auth)

4986 COMMENTS ON THE PAPER "NEUTRON IRRADIATION DAMAGE IN MOLYBDENUM. PART I". BY D. M. MAHER AND B. L. EYRE. van der Walt, C. M. (Atomic Energy Board, Pretoria). Phil. Mag.; 24: No. 190, 999-1000(Oct 1971).

The conditions where the contrast from dislocation loops deviates from that of pure edge loops were reexamined, and it was found that the conditions are $\mathbf{b} \cdot \mathbf{n} = 0$ and $\mathbf{n} \cdot \mathbf{g} = 0$, where b is the Burgers vector, n the loop plane normal, and g the diffraction vector. (auth)

Ceramics and Cermets

Refer also to abstracts 4904, 4906, and 4907.

Corrosion and Erosion

4987 (AAEC/E-216) DEVELOPMENT AND TESTING OF CORROSION RESISTANT ALUMINA COATINGS FOR BERYLLIA BASED REACTOR FUEL ELEMENTS. Reeve, K. D.; Ramm, E. J.; Webb, C. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1971. 26p. Dep. NTIS (U. S. Sales Only).

The use of beryllia as the basis of an all-ceramic fuel element for high-temperature reactors cooled by ambient air depends on inhibition of corrosion of beryllium oxide by protecting the surface of the fuel element. Alumina is a promising coating material. The development of corrosion resistant alumina coatings for BeO spheres is described, and results of corrosion, accelerated corrosion, and neutron irradiation tests are presented. The limitations of the coating are discussed in detail. Porous coatings can fail by "undermining," but dense coatings are probably satisfactory for at least two years' operation out-of-pile at 1200°C and for much longer times at lower temperatures. Satisfactory operation at 1200°C for one year has been proved in a long term test. The eventual failure mechanism will probably be associated with the growth of a two layer reaction zone. Neutron irradiation tests indicated that a dose of 10^{20} nvt and possibly 1.6 to 2×10^{20} nvt should be acceptable for retention of coating-to-BeO bond during

simultaneous exposure above 500 to 700°C to fast neutrons and moist air. (auth)

4988 ESTABLISHMENT OF TWO STAGES IN THE OXIDATION OF ZrB_2. Lebugle, Albert; Montel, Gerard (Univ., Toulouse). Compt. Rend., Ser. C: 273: No. 8, 546-9(23 Aug 1971). (In French).

Two temperature ranges must be considered in the oxidation of ZrB_2. In the first range, a slow oxidation occurred following the formation of a continuous film of amorphous zircon at the surface, which was stabilized by boric oxide. In the second range, a rapid oxidation followed the formation of a discontinuous quadratically crystallized zircon layer. (France)

Preparation and Fabrication

Refer also to abstract 4928.

4989 (NUMEC-3524-75) FABRICATION OF LOW DENSITY PuO_2-UO_2 LMFBR FUEL PELLETS. (Nuclear Materials and Equipment Corp., Leechburg, Pa. Plutonium Lab.). Jun 1970. Contract AT(30-1)-3524. 56p. Dep. NTIS.

The development of methods to fabricate reduced-density PuO_2-UO_2 fuel pellets over a density range of 80 to 96% theoretical density and to characterize the porosity attributes of the product is discussed. The process methods used were in conjunction with conventional pressing and sintering techniques. From a production and criticality standpoint, emphasis was placed on processes which were compatible with the existing dry-process flowsheet and equipment. Four methods of density control were evaluated, namely: powder heat-treatment (dead-burned powder); slugging and granulation; burnable organic additions; and precursor-additions ($Pu(OH)_4$-ADU). Each of these methods of density control was evaluated experimentally and the features of each approach are discussed individually. In this study a fuel composition of 20 w/o PuO_2-UO_2 was selected as a reference value. A single lot of coprecipitated mixed oxide powder was used throughout the study in order to minimize the number of variables in evaluating the various methods of density control. All of the work was carried out on regular production line pelletizing equipment with a uniform sintering cycle consisting of 4 hours at 1625°C in a N_2-6% H_2 atmosphere continuous sintering furnace. Test pellets were sintered to a nominal diameter of 0.230 in. with a length to diameter ratio of 1.25. Each of the four methods of fabricating the fuel pellets was shown to have individual characteristics which directly affect its application to pellet fabrication. Some reverse effects and some unexpected stabilization effects were noted. (R.C.K.)

4990 (ORNL-4770, pp 38-60) FAST BREEDER REACTOR OXIDE FUELS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

A program is being conducted to advance the technology of $(U,Pu)O_2$ as a fuel for the Liquid-Metal Fast Breeder Reactor. The determination of the properties and performance of sol-gel-derived oxide fuels fabricated by Sphere-Pac and pelletizing techniques has been emphasized, but comparison with materials derived from other processes such as mechanical blending is a part of the objective. The Sphere-Pac process was used to load a variety of fuel pins for irradiation in the ETR, EBR-II, and ORR. Smear densities in the range 81 to 84% of theoretical are typical. Sol-gel-derived pellets were fabricated with controlled densities from 84 to 97% of theoretical. An equation was developed to predict the time required to reduce mixed oxide fuels to any oxygen-to-metal ratio desired. The Pu/U ratio of sol-gel-derived $(U,Pu)O_2$ fuels varied only slightly from batch to batch and not detectably from sphere to sphere within a batch. The microstructure of these fuels was characterized and the effect of fission products on the structural state and the properties was assessed. The irradiation test program was continued to determine the in-reactor properties and performance of $(U,Pu)O_2$ fuel pins as functions of fabrication form, porosity distribution, stoichiometry, and irradiation conditions. Both fast and thermal neutron irradiations at steady-state, cyclic, and transient power conditions were included. In fast flux tests in EBR-II, five fuel pins containing Sphere-Pac $(U,Pu)O_2$ were irradiated to a calculated peak burnup of 6% FIMA. Two pins were removed for examination and three are being irradiated to 12% FIMA. No fuel-cladding mechanical interaction has occurred at 6% FIMA. The fission gas release rate of 80% agrees with that of other EBR-II-irradiated oxide fuels, and no significant fuel-cladding chemical interaction was detected, even at inner surface temperatures up to 570°C. This is in contrast to the results with non-sol-gel-derived material. Microprobe analysis results showed no fission products in the cladding grain boundaries. Six fuel pins containing unirradiated sol-gel $(U,Pu)O_2$ subjected to transients in the TREAT facility were examined. Both pellet and sol-gel Sphere-Pac fuel behaved the same. One capsule containing Sphere-Pac mixed oxide was irradiated in the ETR to a calculated burnup of 10% FIMA. Other instrumented and uninstrumented irradiations are being continued in the ETR on mechanically blended pellets, sol-gel-derived pellets, and Sphere-Pac material. Results of instrumented tests in the ORR with fuel having a smear density of 82% indicate that fuel-to-cladding thermal conductance in a Sphere-Pac pin is more than that of a pellet fuel pin with a small initial fuel-cladding gap. In ORR instrumented capsules operated at low fuel burnup, very localized cladding attack was seen in the pellet fuel pin but none in the Sphere-Pac fuel. A series of irradiation tests was initiated to measure in-reactor axial extension of the fuel column and cladding and the internal gas pressure developed during operation under carefully controlled prototypic LMFBR power and temperature conditions. Analytical models are being developed for predicting and evaluating the performance of LMFBR fuel pins and detailed examinations of irradiated fuel pins are being performed for comparison. The FMØDEL fuel performance code was modified for steady-state, power cycling, and limited transient applications. It now includes a dynamic model for fuel restructuring based on a vapor-condensation mechanism of pore migration, subroutines for grain growth and plutonium redistribution, a fuel cracking model, and an improved cladding mechanical model to include neutron-enhanced creep. The code has been used in a variety of applications and shown excellent correspondence between calculated and measured diametral expansions, restructuring, center-line temperatures, and porosity distribution. Work in support of the integrated fuel performance modeling effort has included replica electron microscopy of irradiated $(U,Pu)O_2$ to improve understanding of fuel restructuring, porosity distribution, fuel swelling, and fission gas release and has included an investigation of the kinetics of in-reactor and out-of-reactor $(U,Pu)O_2$ grain growth, actinide and oxygen redistribution in irradiated $(U,Pu)O_2$, and radial porosity distribution. In each case the physical observations have been used concurrently with development of mathematical description. Other activities include improvements and analysis for cladding deformation, a survey of fuel-cladding chemical interactions, and measurement of the properties of stainless steel tubing used for cladding. (auth)

4991 (ORNL-4770, pp 61-8) ADVANCED FAST BREEDER REACTOR FUELS DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Thermal flux irradiation of eight mixed nitride fuel pins is in progress in the ETR. The peak linear heat rate is 30 kW/ft with scheduled exposures of 30,000 and 60,000 MWd/metric ton. Seven fuel pins were fabricated for testing in the EBR-II. (U,Pu)N fuel and UN insulator fuel for eight EBR-II pins were produced and characterized. The sintering of UN and $U_{0.8}Pu_{0.2}N$ depends on the nitrogen pressure. The sintering of mechanically mixed (U,Pu)N is limited by low-density regions at the original sites of the PuN particles. The nitrogen in mononitride and sesquinitride phases can be accurately determined by the Dumas method; the Kjeldahl technique with phosphoric acid dissolution is satisfactory only for mononitride. The lattice parameter of (U,Pu)N does not obey Vegard's law. (auth)

4992 (ORNL-4770, pp 171-5) THORIUM UTILIZATION. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The objective of the Thorium Utilization Program is to demonstrate economic processes and techniques for the Th-^{233}U fuel cycle for the High-Temperature Gas-Cooled Reactor. Fabrication processes and equipment are being developed to handle the highly radioactive recycle fuel, and the fuel designs of interest are being irradiation tested. The program is to demonstrate recycle capability starting in 1976. Maintenance and improvement of TURF was continued along with development of refabrication, with emphasis on engineering-scale deposition of pyrolytic carbon and bonding coated fuel particles with a carbonaceous matrix. Irradiation of a number of recycle fuel particle types in the Peach Bottom Reactor and the Engineering Test Reactor was initiated. A comprehensive program plan for the national demonstration of HTGR fuel recycle technology was developed. (auth)

4993 (ORNL-4770, pp 199-200) POWDER PROCESS DEVELOPMENT FOR LWBR. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Processes and specifications for producing $^{233}UO_2$ powder are being developed. Bettis Atomic Power Laboratory personnel will blend this powder with ThO_2 for pelletization. In the UO_2 powder

process ammonium diuranate is precipitated from the nitrate solution with gaseous ammonia, centrifuged from its supernate, dried by microwave heat, and reduced by hydrogen at 600 to 700°C; the reduced powder is then stabilized. This process differs from usual UO_2 production processes in the centrifugation step and the use of microwave drying. Microwave drying appears to be attractive for commercial preparation of UO_2, PuO_2, and $(U,Pu)O_2$ powders. Limited parametric studies were carried out in precipitation, centrifugation, drying, reduction, and stabilization. In addition to developing the $^{233}UO_2$ process specifications, 18 kg of fully enriched UO_2 powder was produced by the developed processes for evaluation by BAPL. (auth)

4994 PREPARATION OF URANIUM CARBIDES AT LOWER TEMPERATURES. Gutu, Anca; Iorgulescu, S.; Jitea, I. Rev. Roum. Sci. Tech., Ser. Met.; 15: No. 1, 63-74(1970). (In French).

The thermodynamics of carbide formation are examined theoretically as an introduction to an experimental study of the reduction of UO_2 by C in an atmosphere of H. It is shown that a mixture of UC and UC_2 formed at 1400°C from very-finely-divided mixtures of UO_2 and C can be converted to ~98% UC by further heating in H at 1400°C. The role of H in the reduction is discussed. (Metals Abstr.)

4995 COATING FOR FUEL ELEMENT CANS. (to Commissariat a l'Energie Atomique). British Patent 1,250,687. 20 Oct 1971. Priority date 7 Oct 1968, France.

A barrier to prevent diffusion of U or U alloy fuels through Zr alloy or Mg alloy cladding is described. The barrier consists mainly of graphite in nitrocellulose as a suspension. The suspension is applied to the fuel can surface at high enough temperature to eliminate the nitrocellulose solvent and forming a graphite deposit. (J.R.D.)

4996 METHOD FOR THE PRODUCTION OF FUEL ELEMENTS. Richter, Karl; Bouillet, Jean Marie; Lesser, Richard; Gabolde, Jean (to EURATOM). British Patent 1,251,640. 27 Oct 1971. Priority date 22 Aug 1969, Germany.

A method is described for the production of fuel elements for fast breeder reactors or experimental or test reactors. The fuel elements substantially comprise a core of breeder material or neutral material, a stratum of fissile material disposed around said core and a sheath surrounding the fissile material. The core, in the form of tablets or rods having been stacked one upon the other to form a column, or in the form of a rod, is first disposed in the sheath after which the fissile material, in the form of particles, is introduced between the core and the sheath by vibration, the maximum particle diameter being approximately equal to the desired distance between the core and the sheath. (P.C.H.)

4997 NOTE ON THE THICKNESSES OF ANODIZED NIOBIUM OXIDE FILMS. Chiou, Y. L. (Univ. of Illinois, Chicago). Thin Solid Films; 8: No. 4, R37-9(Oct 1971).

Experiments on niobium oxide films grown by anodization are reported which show that the thickness also depends on the time the oxide is held at the final voltage. In the experiments, spectral responses, interference colors, and electrical characteristics were studied. It is shown that an error of several hundred angstroms may result if the thickness is estimated by multiplying the proportional constant (24 Å V^{-1}) by the final voltage. (D.L.C.)

4998 SPUTTER DEPOSITION OF EuO THIN FILMS. Coburn, J. W.; Lee, Kenneth (IBM Research Lab., San Jose, Calif.). J. Appl. Phys.; 42: No. 13, 5903-5(Dec 1971).

High-quality EuO films with properties similar to bulk EuO have been deposited by sputtering a polycrystalline EuO target in an ultrahigh vacuum sputtering system. In addition, Eu-rich EuO films with enhanced ferromagnetic properties have been sputter deposited, but with considerable difficulty. The difficulty is caused by oxidizing impurities present in the vacuum system and is sufficiently severe as to indicate that multiple-source vaporization is a more suitable technique for fabricating Eu-rich EuO films with the enhanced ferromagnetic properties required for beam-addressable file applications. (auth)

4999 NUCLEAR REACTOR FUEL ELEMENTS AND METHODS OF MAKING SAME. (to Atomic Energy of Canada Ltd.). British Patent 1,251,400. 27 Oct 1971. Priority date 4 Jun 1968, United States.

A fuel element is described which comprises a corrosion-resistant alloy sheath surrounding U–Si alloy core containing voids. Methods of fuel element fabrication in the form of rods or billets are also described. (J.R.D.)

Properties Evaluations

Refer also to abstracts 4466, 4934, 4944, 4952, 5645, and 5648.

5000 (ORNL–4770, pp 18-19) FUNDAMENTAL AND PHYSICAL CERAMICS RESEARCH. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Deformation of hyperstoichiometric UO_2 single crystals was investigated. Deformation studies of $Ca_{1-x}Y_xF_{2+x}$ are in progress. A TGA/vapor pressure apparatus has been built for high-temperature nitride research. (auth)

5001 (ORNL–4770, pp 34-7) X-RAY DIFFRACTION. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The technique developed to analyze diffuse x-ray scattering from imperfectly ordered binary alloys was applied to data from Cu–16 at. % Al and Au–40 at. % Ni. An x-ray diffraction study of short-range structure in $(CaF_2)_{1-x}(YF_3)_x$ crystals should improve both experimental methods and the power of interpretive schemes. Bremsstrahlung produced by photoelectrons generated in matter by absorption of monoenergetic x-ray beams has been observed and its general features measured. Important advances in x-ray fluorescence analysis will be developed from this experimental arrangement. Additional x-ray diffraction observations of aging reactions in gamma-quenched uranium-base alloys provided clues to the "memory" effects shown by the material. Aspects surrounding the crystal structure of boron carbide and diffraction data on neutron-irradiated crystals of B_4C are being studied. Small-angle x-ray scattering studies of neutron-irradiated aluminum crystals have shown effects due to radiation-induced voids. Progress in accurate absolute intensity calibrations for high- and low-angle x-ray scattering measurements follows from recent experimental correlation of two disparate techniques. (auth)

5002 (ORNL–4770, pp 195-8) NERVA PROGRAM METALLURGICAL SUPPORT. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The outgassing characteristics of NERVA XE II fuel elements were determined in simulated space environments for temperatures between 50 and 870°C. Elements were tested both as received and after firing above 2000°C in hydrogen. The results were used to predict the gaseous environment in the reactor core exit plenum chamber. The frictional behavior of NERVA graphite was shown to be very sensitive to both wear and surface contamination. Both uncontaminated surfaces and wear are required to cause the coefficient of friction to increase from the values in air (~0.25) to those observed under conditions of heavy loading in vacuum (>0.6). Baseline data are being provided for thermal conductivity, electrical resistivity, and thermopower of the NERVA materials for use in irradiation tests. The results of thermal conductivity measurements on P-03 graphite are reported from 300 to 1000°K. (auth)

5003 (ORO–4212-8) QUANTITATIVE DETERMINATION OF THE STRUCTURE: PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Quarterly Progress Report, March 15, 1971–June 15, 1971. Rhines, F. N.; DeHoff, R. T.; Whitney, E. D. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Jul 1971. Contract AT(38-1)-552. 75p. (SRO–552-8). Dep. NTIS.

Progress in the development of techniques of quantitative microscopy is reviewed beginning with a quantitative analysis of fracture surfaces through porous bodies. An analysis of the curvature of lineal features in space is included along with a scanning electron microscope view of the evolution of structure in sintering. Measurements of microstructural states for various combinations of powder selection and subsequent treatment are presented along with corresponding property determinations. Results are included for nickel and for UO_2 sinterings. Information is also included on specimen preparation; quantitative microscopy; gas permeability; thermal conductivity; short time mechanical properties; and creep behavior. A review of equipment which has been constructed and designed during the last year is given. (auth)

5004 MICROHARDNESS OF CARBIDE ALLOYS OF NIOBIUM AND TITANIUM IN THE HOMOGENEOUS REGION. Samsonov, G. V.; Upadkhaya, G. Sh. Vestn. Kiev. Politekh. Inst., Ser. Mashinostr.; No. 6, 161-4(1969). (In Russian).

A study was made of the microhardness of the monocarbides of Ti, Nb, and their alloys in the homogeneous region. The microhardness increases with increase in the bound C content, this being explained by the reinforcement of the metal–C bond. The maximum value of microhardness was obtained with the alloy $Nb_{0.25}Ti_{0.75}C_x$. This can be explained by the different degree of statistical weight-loading of metal atoms with stable d^5 configura-

tions in the Metal^{I} – Metal^{II} bond in the formation of the carbide alloy. (Metals Abstr.)

5005 DECREASE IN CARBON CONCENTRATION IN Mo_2C AND W_2C SURFACE LAYERS. Sotnikov, V. T.; Red'kin, V. S.; Zashkvara, V. V.; Chaikovskii, E. F.; Korsunskii, M. I. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 878-80(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1058-61(Apr 1971).

By reflecting a primary beam of 800-eV electrons for two scattering angles (φ = 39 and 141°), the characteristic energy loss spectra for Mo_2C and W_2C specimens prepared by heating pure Mo and W strips in benzene vapors were investigated. During the recording of the spectra, the specimens were heated to 2000°C at a pressure of 10^{-6} torr. It was established that the initial specimens had an increased carbon concentration in layers close to the surface. During a high-temperature heating of the Mo_2C and W_2C specimens, however, carbon was seen to desorb from these layers, causing the composition of the compound in the surface regions to approach that of the pure metal (Mo, W). (auth)

5006 MONOCHROMATIC EMISSIVITY OF COMMERCIAL POLYCRYSTALLINE GRAPHITES. Abramov, A. S.; Barykin, B. M.; Romanov, A. I.; Spiridonov, E. G. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 62-5(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 74-9(Jan-Feb 1971).

Results are presented for PG-2, GMZ, and PG-50 commercial polycrystalline graphites at 0.55 μm and 4-10 μm at high temperatures. The results are compared with published values and with Drude's classical theory. Results are also given on the electrical resistivity of graphite at high temperatures. (auth)

5007 THERMAL CONDUCTIVITY OF PYROGRAPHITE AT HIGH TEMPERATURES. Chekhovskoi, V. Ya.; Petrov, V. A.; Petrova, I. I.; Lyukshin, E. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 66-9 (Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 80-4(Jan-Feb 1971).

The thermal conductivity coefficients of pyrographite specimens with different wall thicknesses for a direction normal to the precipitation direction were determined in the temperature range 1200 to 2500°K. The results obtained are compared with the data of other workers. (auth)

5008 THERMAL EXPANSION OF THE DIBORIDES OF THE TRANSITION METALS OF GROUPS IV AND V. Samsonov, G. V.; Kovenskaya, B. A.; Serebryakova, T. I.; Tel'nikov, E. Ya. (Inst. of Problems in Materials Science, Kiev). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 170-2(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 195-7(Jan-Feb 1971).

The thermal expansion of TiB_2, ZrB_2, HfB_2, VB_2, NbB_2, and TaB_2 was measured at 300 to 2500°K. All the coefficients α increase slightly from 300 to 1300°K and become practically constant at higher temperatures. The characteristic temperature θ was calculated and compared with the elastic–dynamic properties of the borides (Young's modulus, mp, compressibility, and phonon component of thermal conductivity). The properties correlate, and it is concluded that the interatomic bond strength decreases from the group IV diborides to those of group V. (D.L.C.)

5009 THERMAL EXPANSION OF METAL DODECABORIDES. Paderno, Yu. B.; Odintsov, V. V.; Timofeeva, I. I.; Klochkov, L. A. (Inst. of Problems in Materials Science, Kiev). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 175-7(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 200-2(Jan-Feb 1971).

Thermal expansion coefficients were measured at 78 to 1300°K for metal dodecaborides having the cubic UB_{12}-type structure: YB_{12}, TbB_{12}, DyB_{12}, HoB_{12}, ErB_{12}, TmB_{12}, YbB_{12}, LuB_{12}, and ZrB_{12}. Characteristic temperatures and averaged mean square amplitudes of thermal vibrations were calculated from the thermal expansion. The vibration amplitudes are much less in the dodecaborides then in the metals and practically identical for all the dodecaborides, confirming the dominant part of boron in the structure. (D.L.C.)

5010 HIGH-TEMPERATURE EMISSIVITY OF ZIRCONIUM CARBIDE. Kolesnichenko, A. N.; Krasnoshchekov, Yu. A.; Nezhevenko, L. B.; Pustogarov, A. V. High Temp. (USSR) (Engl. Transl.); 9: No. 1, 178-80(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 202-4(Jan-Feb 1971).

Monochromatic emissivity ϵ_λ was measured at 0.65 μm at 1500 to 3500°K on ZrC tubes. ϵ_λ falls from 0.85 to 0.75 between 1500 and 2500°K, followed by a sharp fall to 0.52, in pure He. The use of unpurified He results in a smooth decreasing line, indicating that the emissivity is dependent on the atmosphere, especially at high temperatures. The measured values are compared with previously published ones. (D.L.C.)

5011 DENSITY MEASUREMENT ON MOLTEN BORON OXIDE AT HIGH TEMPERATURES BY HYDRODYNAMIC WEIGHING. Shpil'rain, E. E.; Yakimovich, K. A.; Tsitsarkin, A. F. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 58-61(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 67-73(Jan-Feb 1971).

A method is given for measuring the density of hot materials of high viscosity. The apparatus is described and results are given for liquid boron oxide at 850 to 2000°C, with a maximum error of ±0.25%. (auth)

5012 GASCHROMATOGRAPHIC STUDY OF THE BEHAVIOR OF CARBON AND OXYGEN CONTAINED IN WC + Co MIXED POWDERS WHEN HEATED IN HYDROGEN ATMOSPHERE. Miyoshi, Akiyoshi (Tokyo Tungsten Co. Ltd.); Hara, Akio; Kubota, Haruo. Funtai Oyobi Funmatsuyakin; 18: No. 1, 23-7(Jul 1971). (In Japanese).

The change in the content of carbon and oxygen that occurs when the WC + Co mixed powder or compact is heated in a hydrogen atmosphere was observed. Reactions of carbon and oxygen were studied during heating of WC + 5% and 10% Co ball milled powders in the hydrogen atmosphere under various conditions. The changes of carbon and oxygen content after heating were estimated by chemical analysis. The gases generated in the atmosphere were measured by using a gaschromatograph and a dew point meter. It was found that decarburization and reduction occurred even at 200°C; below about 600°C, only CH_4 was generated as the result of decarburization. At higher temperatures, CO gas was generated, and with an increase of temperature the amount of CO gas increased while that amount of CH_4 gas decreased; below about 600°C, H_2O gas was generated as the result of reduction; below about 600°C, the H_2O content in hydrogen did not affect decarburization but at higher temperatures the moisture in hydrogen increased decarburization greatly; and these phenomena can be explained thermodynamically. (auth) (Japan)

5013 ENTHALPY OF FORMATION OF DYSPROSIUM SESQUIOXIDE. Huber, Elmer J. Jr.; Fitzgibbon, George C.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Thermodyn.; 3: No. 5, 643-8(Sep 1971).

The value for the enthalpy of formation of dysprosium sesquioxide was confirmed by two sets of independent measurements involving the use of an oxygen bomb calorimeter and a solution calorimeter. The value obtained from the former was $\Delta H_f^0(Dy_2O_3, 298.15\ K) = -(445.3 \pm 1.0)$ kcal mol^{-1}, and from the latter $\Delta H_f^0 = -(445.5 \pm 1.6)$ kcal mol^{-1}, to give a weighted average of $-(445.32 \pm 0.85)$ kcal mol^{-1}. (auth)

5014 ENTHALPY OF MOLYBDENUM DISULFIDE TO 1200°K BY DROP CALORIMETRY. Fredrickson, D. R.; Chasanov, M. G. (Argonne National Lab., Ill.). J. Chem. Thermodyn.; 3: No. 5, 693-6(Sep 1971).

A high-precision drop-calorimetric system was used to measure the enthalpy (relative to 298.15°K) of MoS_2 in the temperature range 500 to 1200°K. All temperatures are based on IPTS-48. The results can be represented by the following equation, which should be used only over the experimental range: $H^0(T) - H^0(298.15°K) = \{16.8278(T/K) + 9.4045 \times 10^{-4}(T/K)^2 + 5.1881 \times 10^4(T/K)^{-1} - 5495.38\}$ cal mol^{-1}. Values of $C_p^0(T)$, $H^0(T) - H^0(298.15°K)$, $S^0(T)$, and $\{G^0(T) - H^0(298.15°K)\}/T$ are tabulated. (auth)

5015 CALORIMETRIC DETERMINATION OF THE ENTHALPY OF VAPORIZATION OF MoO_3. Charlu, T. V.; Kleppa, O. J. (Univ. of Chicago). J. Chem. Thermodyn.; 3: No. 5, 697-700(Sep 1971).

The enthalpy of vaporization of MoO_3(l) was determined from high-temperature calorimetric studies. A best value of $\Delta H_v = (12.26 \pm 0.35)$ kcal mol^{-1} was obtained. (auth)

5016 INFRARED SPECTRA OF MATRIX ISOLATED UO AND UO_2. Leary, H. J. Jr.; Rooney, T. A.; Cater, E. D.; Friedrich, H. B. (Univ. of Iowa, Iowa City). High Temp. Sci.; 3: No. 5, 433-43(Sep 1971).

The molecules UO and UO_2 were vaporized from tantalum and tungsten Knudsen cells containing variously a urania–uranium mixture, solid urania of natural isotopic composition, and solid urania, 60% enriched in oxygen-18, in the temperature range 2300 to 2500°K. The molecules were trapped in argon and krypton matrices at 4 and 20°K and studied spectroscopically from 4000 to 50 cm^{-1}. Positively identified vibrational frequencies in argon

matrices are 773 cm^{-1} for $U^{16}O$, 734 cm^{-1} for $U^{18}O$, and the frequencies 869, 853, and 825 cm^{-1} for one of the stretching modes of the UO_2 molecule of respective isotopic composition $U^{16}O_2$, $U^{16}O^{18}O$, and $U^{18}O_2$. The second stretching frequency and the bending frequency of UO_2 were not observed. (auth)

5017 DIFFUSION OF CARBON IN SOME ALLOYS OF NIOBIUM WITH TUNGSTEN OR MOLYBDENUM. Lyubimov, V. D.; Tskhay, V. A.; Bogomolov, G. D. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 48-51(1970). (In Russian).

Determinations were made of the diffusion properties of C in Nb–W and Nb–Mo solid-solutions containing W 5, 10, 20, and 30 wt % and Mo 5 to 20 wt %, during a diffusion anneal at 800 to 1250°C. The diffusion coefficient D, of C in these alloys is little different from D in pure Nb, and changes in the concentration of the alloying element have little effect upon the C mobility. The activation energy for diffusion of C in Nb-base alloys is much less than the value in pure metals. In the region 3 to 6 at. % Mo or W, the activation energy value shows an appreciable min while the self-diffusion activation energy reaches a maximum. (Referativnyi Zh.)

Structure and Phase Studies

Refer also to abstracts 5642 and 5650.

5018 HIGH-RESOLUTION ELECTRON MICROSCOPY OF CRYSTAL LATTICE OF TITANIUM–NIOBIUM OXIDE. Iijima, Sumio (Arizona State Univ., Tempe). J. Appl. Phys.; 42: No. 13, 5891-3(Dec 1971).

The detailed structure within the two-dimensional projection of the unit cell of a $Ti_2Nb_{10}O_{29}$ crystal, showing the arrangement of the metal atoms, has been revealed by careful use of a high-resolution electron microscope. The image shows good agreement with the model of the structure deduced from x-ray diffraction studies. (auth)

5019 SYSTEM UO_2–UO_3–$LaO_{1.5}$. Diehl, H. G.; Keller, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Solid State Chem.; 3: No. 4, 621-36(Nov 1971). (In German).

At 1250°C, the following five single-phase regions were found in the UO_2–UO_3–$LaO_{1.5}$ region of the ternary uranium–lanthanum–oxygen system: (a) β–U_3O_8: no solubility for $LaO_{1.5}$ could be observed. (b) Fluorite phase: concerning the oxygen:metal ratio this phase may exist superstoichiometrically as $(U,La)O_{2+x(ss)}$ $(0 \leq x \leq 0.25)$, substoichiometrically as $(U,La)O_{2-x(ss)}$ $(0 \leq x \leq 0.40)$, and stoichiometrically as $(U_{1-y}, La_y)O_{2(ss)}$ $(0 \leq y \leq 0.67)$. (c) Rhombohedral phase I: as concerns the U:La ratio, this ordered phase occurs stoichiometrically at the limiting compositions $UO_3 \cdot 6LaO_{1.5}$ (Me_7O_{11}) with tetravalent uranium and $UO_3 \cdot 6LaO_{1.5}$ (Me_7O_{12}) with hexavalent uranium, showing a maximum of phase width with the limiting compositions $UO_{2.5} \cdot 5LaO_{1.5}$ and $UO_{2.5} \cdot 7LaO_{1.5}$. (d) Rhombohedral phase II: this phase extends from 71.5 to 76.5 mole-% $LaO_{1.5}$ for U(VI) and shows only little phase widths concerning the O:Me ratio. Above 1310°C, this ordered phase transforms reversibly to a disordered phase having fluorite structure. (e) $LaO_{1.5}$: no solubility for UO_{2+x} could be observed. In the pseudo-binary system UO_{2+x}–$LaO_{1.5}$ ($p(O_2) = 1$ atm), a third rhombohedral phase R III (Me_6O_{11}) occurs between 55 and 66.7 mole-% $LaO_{1.5}$ ($T \leq 1220$°C). The limiting composition of this phase regarding the highest content of lanthanum as well as that of oxygen is $(U_{\frac{1}{6}}, La_{\frac{1}{6}})O_2$. Below 1550°C, the mean valency of uranium in UO_{2+x}–$LaO_{1.5}$ mixed oxides at $p(O_2) = 1$ atm is rather independent of the annealing temperature but markedly increases with rising content of lanthanum in the samples. A valency of exact 6.00 is observed for mixed oxides containing 66.7 mole-% $LaO_{1.5}$ or more. (auth)

5020 SINTERING OF BeO AND GRAIN GROWTH UNDER HIGH-PRESSURE. Kodaira, Kohei; Kanamaru, Fumikazu; Koizumi, Mitsue (Osaka Univ., Suita, Japan). Funtai Oyobi Funmatsuyakin; 18: No. 1, 19-22(Jul 1971). (In Japanese).

Submicron particles of BeO without additives were subjected to temperatures ranging from 1000 to 1400°C and pressure at 20 kbars. Translucent specimens with theoretical density were fabricated in the case when sintering time was longer than 5 minutes. The optical transmissions in the visible range were determined to be about 60% for the specimen with the thickness of 0.8 mm sintered at 1000 to 1200°C. Concerning the grain growth of polycrystalline body, there exists the following relation between grain size (D) and sintering time (t): $D = Kt^n$. The value of n in the above formula was determined to be ½ for this study. The activation energy for grain growth was calculated at 44 kcal/mol from the slope in the log K/n vs. 1/T plots. (auth) (Japan)

5021 PHASE BEHAVIOR AND CRYSTAL STRUCTURE OF ACTINIDE NITRIDES. Tagawa, Hiroaki (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 5, 267-74(May 1971). (In Japanese).

A review was made on the properties of nitrides of actinide elements in general and nitrides of thorium, uranium, neptunium, plutonium, and americium, especially on crystal structure, lattice constants, chemical stoichiometry, physical properties, addition compounds, and solid solutions. The equilibrium diagrams for Th–N, U–N, and other systems are discussed. Chemical composition of the nitrides of actinide elements is usually given by AnN, where An is actinide elements. Lattice structure of AnN is face centered cubic of NaCl type. Although the chemical composition of AnN is stoichiometric at room temperature, ThN and UN dissolve excess metal or N at above 1,000°C, and show some deviation from the stoichiometric composition. Neel temperatures of UN and PuN are 52 and 120°K, respectively. NpN shows ferromagnetism with Curie point of 84°K. Electric resistance of UN and PuN increases continuously with rising temperature, but that of NpN reaches maximum at 854°K, and decreases above this temperature. Nitrides of Th and U form additional compounds with elements of Groups Vb, VIb, and VIIb. (Japan)

5022 HIGH TEMPERATURE MICROSCOPY STUDIES. Dannoehl, H. D.; Graber, R.; Wegmann, L. (Balzers AG, Liechtenstein). Microstructures; 2: No. 5, 15-18; 31(Aug-Sep 1971).

The development of a photoemission electron microscope marks a great progress towards realistic high temperature microscopy studies of surfaces of solids in the whole temperature range from room temperature to 2000°C. The instrument described offers pronounced orientation and material contrasts at any temperature without etching for flat polished specimens of any crystallographic structure with resolutions down to 150 Å. Built in the instrument running with a normal working vacuum of 5×10^{-7} torr are facilities for long time studies, for specimen preparations like ion cleaning, ion etching, coating, and quenching, for gas reaction experiments. Examples for the instrument's application in studying recrystallization or segregation processes, cemented carbides, and refractories are shown; more are cited in literature. (auth)

5023 STUDY OF α-TITANIUM–OXYGEN AND α-ZIRCONIUM–OXYGEN SOLID SOLUTIONS. PART 3. MECHANICAL CHARACTERISTICS OF α TITANIUM–OXYGEN AND α ZIRCONIUM–OXYGEN HOMOGENEOUS SOLID SOLUTIONS. Dubertret, Alain (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Metaux (Corros.-Ind.); 46: No. 547, 87-105 (Mar 1971). (In French).

α titanium–oxygen and α zirconium–oxygen solid solutions are characterized by the existence of the substructures Ti_2O_{1-x}, Ti_2O, Ti_3O, Ti_6O and Zr_3O_{1-x}, Zr_3O_1, Zr_3O_{1-x}, Zr_6O. These substructures are characterized by hardness minima corresponding to the ordered Ti_2O, Ti_3O, Ti_6O and Zr_3O, Zr_6O alloys. Alpha zirconium–oxygen solid solutions formed during the oxidation of Zr by oxygen dissolution in the underlying α zone of the oxide present the same anomalies as those encountered in homogeneous solid solutions. The hardness measurements are not sufficiently accurate to allow the dependence of the oxygen diffusion coefficient in α Zr to be observed by considering the element concentration or the effect of the ordered arrangement of oxygen atoms on the diffusion. (France)

5024 NIOBIUM CORNER OF THE TERNARY SYSTEM Nb–Ti–B. Zakharov, A. M.; Novikov, I. I.; Pshokin, V. P. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 111-14(1971). (In Russian).

The niobium corner of the Nb–Ti–B ternary phase diagram was investigated in the temperature range 1,000 to 2,000°C up to 6% B and 8% Ti. The solidus curve was constructed for the isothermal sections at 1,800 and 1,100°C. The presence of the borides Nb_3B_2, and (Nb, Ti)B, and of a eutectic α–Nb_3B_2 was noted, and their solubility in Nb in the solid state was measured. (K.S.W.)

5025 MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES. V. THE PLUTONIUM–CARBON SYSTEM. Kent, R. A. (Los Alamos Scientific Lab., N. Mex.). pp 1124-31 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A mass spectrometric-Knudsen effusion study of the vaporization of the plutonium–carbon system has shown that there are three regions to the Pu–C phase diagram which give rise to invariant but not congruent vaporization including monocarbide plus sesquicarbide, sesquicarbide plus carbon, and dicarbide plus carbon. The low carbon sesquicarbide phase boundary curves to the left at high temperatures, passing through the composition $PuC_{1.41}$ at 1550 ± 25°C. The transition from sesquicarbide to dicarbide occurs at 1660 ± 10°C. In addition, the standard heat

and entropy of formation for the mono- and sesquicarbide have been determined. (auth)

5026 EXISTENCE OF THE PHASE p-U_3O_8. Tsvigunov, A. N.; Kovba, L. M. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 769(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 795(Sep-Oct 1970).

Conversion of $\alpha-U_3O$ was studied at pressures of 2000 to 2800 bars. Indexes obtained from x-ray-diffraction pictures showed that $\gamma-U_3O_8$ is a mixture $\alpha-U_3O_8$ and $\beta-U_3O_8$. No monochromatic lattice distortion in $\alpha-U_3O_8$ was detected. (tr-auth)

5027 Th–C–N PHASE DIAGRAM. Benz, Robert; Troxel, Jimmie E. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.: 3: No. 5, 422-32(Sep 1971).

Based upon x-ray diffraction powder patterns and microscopic examination of annealed and quenched alloys and thermal analyses, phase relations in thorium–carbon–nitrogen isotherms are deduced for nitrogen pressures up to 2 atm and temperatures from 1400 to 2200°C. An incongruent stationary point exists at 1720 ± 30°C between the four phases, liquid thorium, α-thorium, β-thorium, and face-centered cubic Th(C,N). Nitrogen solubility in ThC_2 is ≤ 0.4 wt % up to 1800°C. The solubility increases by 0.3 wt % between 2000 and 2200°C. Addition of nitrogen raises the $\alpha-\beta$ transition in thorium-rich ThC_2 from 1255 to 1385°C and raises the apparent critical point of the $ThC-ThC_2$ miscibility gap to a ternary eutectic at 2200°C. Carbon solubility in Th_3N_4 does not exceed 0.2 wt % up to 2000°C. A ternary phase exists with the composition $ThC_{0.96\pm0.02}N_{0.96\pm0.02}$ having virtually no composition range. (auth)

5028 STRUCTURE DEFECTS IN CERIUM DIOXIDE. Wilbert, Yves; Oehlig, J. J.; Duquesnoy, Alain (Univ., Amiens, France). Compt. Rend., Ser. C; 273: No. 8, 550-3(23 Aug 1971). (In French).

The cubic phase, $Ce_{1+y}O_2$ was studied at thermodynamic equilibrium (T and p_{O_2}) by thermogravimetry, conductivity measurements, and high temperature x-ray diffraction techniques. The results are interpreted by the presence of Ce_i atoms and Ce_i^{4+} ions in interstitial positions in the lattice. The limit towards the hexagonal Ce_2O_3 oxide side is defined in the log p_{O_2}, T°K diagram by the equation: $\log p_{O_2} = -43{,}450(1/T°K) + 13.3$. (France)

Radiation Effects

Refer also to abstracts 6230, 6232, 6233, 6242, and 6396.

5029 (ORNL–4770, pp 102-4) FAST BREEDER NEUTRON ABSORBER MATERIALS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Characterization of and the effect of irradiation damage on neutron absorber materials are being investigated. Improved methods for indexing the x-ray diffraction powder patterns of boron carbide were developed, and patterns of the irradiated powder were interpreted. The microstructure of irradiated boron carbide powders was investigated by transmission microscopy. Damage typical of displacement damage in metals was observed, but no evidence of helium bubbles or other evidence of reaction product agglomeration was found. Free boron as a contaminant in boron carbide was shown to greatly increase the helium release rate during irradiation. (auth)

5030 (ORNL–4770, pp 120-3) URANIUM NITRIDE FUELS. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

The performance of UN fuel at 1500°C was satisfactory for 5800 hr of irradiation at ~9 kW/ft. The T-111 cladding of two fuel pins developed voids and cracks, leading to failure of one fuel pin. The third fuel pin had W–25% Re cladding and performed satisfactorily. Three additional capsules were fabricated to irradiate nine fuel pins at 1000°C cladding temperature—six with UN in T-111, two with UO_2 in Nb–1% Zr, and one with UO_2 in T-111. The UO_2 fuel is for evaluation of the backup design. (auth)

5031 (ORNL–4770, pp 124-7) FUEL ELEMENT FABRICATION DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

An irradiation experiment to determine the factors controlling the upper burnup limit of ATR and HFIR type fuels was completed. Manufacturing yields for the HFIR fuel element continued to increase, to a net of 97.8% for fuel plates fabricated in FY 1971. New x-ray attenuation standards for fuel homogeneity were based on more precise chemical sampling and analysis techniques. The deformation studies on dogboning were completed. Shaped cores are a solution if the cladding strength is at least half that of the core. Examination of a small failed section from an ATR fuel plate showed no evidence of foreign material within the core. Thermal conductivity of aluminum-U_3O_8 cermets was smaller for burned than high-fired U_3O_8 and consistent with expectations for aluminum containing dispersed insulator and void space. (auth)

5032 (ORNL–4770, pp 140-8) GAS-COOLED REACTOR PROGRAM. (Oak Ridge National Lab., Tenn.). Sep 1971.

In Metals and Ceramics Division annual progress report for period ending June 30, 1971.

Particles of $(Th,U)O_2$ or $(Th,U)C_2$ coated with pyrolytic carbon and SiC offer considerable advantage as fission-product-retaining fuel for high-temperature gas-cooled reactors (HTGR's). Coating materials and simulated fuel elements are prepared, characterized, and irradiation tested to high fast fluence. Coated-particle beds bonded with coal-tar pitch containing high concentrations of a variety of carbonaceous filler materials survived full HTGR fast fluences without loss of integrity or coating failures. However, blended beds of loose particles suffered severe shrinkage and settling. Techniques of fabricating less expensive or more stable fuel sticks are being developed and tested. An important recent contribution has been the development of coated particles derived from ion exchange resins. Certain resin spheres retain their shapes when carbonized slowly in a fluidized bed, and stable coatings may be applied to them. Sufficient uranium may be absorbed in such particles before carbonizing to make them an attractive alternate to the small fissile particles in the HTGR fuel cycle. Such particles have performed well to a burnup of 20 at. % heavy metal and full HTGR fast neutron fluence. The Program also contributed to the development of fuel elements for a gas-cooled fast breeder reactor (GCFBR). A $(U,Pu)O_2$ fuel and fuel pin were prepared for a test of a new manifolded-vented fuel element design. This instrumented fuel pin has performed satisfactorily for about half of a planned irradiation to 75,000 MWd/ton. Testing of GCFBR fuel pins in EBR-II at temperatures ranging from 600 to 800°C is in progress. (auth)

Plastics and Other Materials

Refer also to abstracts 4318 and 4526.

5033 IMPROVEMENTS TO A PROCESS FOR RADIATION HARDENING OF VARNISH AND PAINT, AND EQUIPMENT NECESSARY FOR ITS APPLICATION. Meunier, Jean-Paul (to Conservatome Industrie). French Patent 2,045,643. 5 Mar 1971. Filed 13 Jun 1969. (In French).

A process for the radiation hardening of a varnish or paint coating is presented. The varnish or paint layer is solidified by irradiation in an atmosphere free from air and O. After a first irradiation, the layer is coated with an inert shielding liquid. A second irradiation is performed and the shielding liquid is eliminated. The paint layer obtained is smooth, hard, and difficult to scratch with the nails. The process is cheap. Equipment for the application of the process is also presented. (France)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 4180.

5034 (ORO-3235-72) NUCLEAR AND COSMOCHEMISTRY. Annual Progress Report. (Arkansas Univ., Fayetteville. Dept. of Chemistry). 31 Jul 1971. Contract AT(40-1)-3235. 25p. Dep. NTIS.

Brief summaries of research on origin and age of the elements, nuclear spectroscopy, fission studies, and instrumentation are presented. A list of papers published or in press is appended. (C.E.S.)

Cosmic Ray Exposure Ages

Refer also to abstract 6328.

5035 MASS SPECTROSCOPIC RESEARCHES IN NUCLEAR PHYSICS AND ISOTOPE COSMOLOGY. Hintenberger, H. (Max-Planck-Institut fuer Chemie, Mainz). pp 3-25 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Mass-spectroscopic researches that should improve the knowledge on the existence and properties of nuclides, as well as on nuclear reactions, are reviewed. Mass-spectroscopic investigations are summarized that should yield new information on the composition and history of terrestrial matter and the evolution of matter in the solar system and in the Universe. (W.D.M.)

5036 XENON PROBLEMS IN METEORITES: A REVIEW. Reynolds, J. H. (Univ. of California, Berkeley). pp 594-607 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Several distinct xenon components that have been identified in meteorites are discussed, starting with components that are understood and proceeding to components about which speculation only is possible. Attention is focused upon the more-recent results, and no attempt is made to comprehensively discuss the extensive literature in the field. (W.D.M.)

5037 INDUCED NONVOLATILE NUCLIDES IN METEORITES. Shima, Masako (Tokyo Univ.). pp 608-20 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The concentration of cosmic-ray-produced stable nuclides of Cr, V, Ti, Ca, and K and two long-lived nuclides, ^{40}K and ^{53}Mn, were determined in iron meteorites. The cosmic-ray-produced ^{40}K in the metallic phase of chondrites was also detected after it was purified by a fractional dissolution method. All the above elements were simultaneously extracted from iron meteorites by a wet chemical method. The contamination level of K, Ca, Ti, and V was of an order of 0.1, 0.4, 0.03, and 0.01 ppM respectively. The mass spectrometry of each element was performed by a surface ionization solid source mass spectrometer. (W.D.M.)

5038 DISTRIBUTION OF SOME STABLE AND LONG-LIVED NUCLIDES PRODUCED BY COSMIC RAYS IN THE IRON METEORITE GRANT. Imamura, M.; Shima, Masako; Honda, M. (Tokyo Univ.). pp 647-51 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Most of the studies on depth effect of the cosmic-ray-produced nuclides in iron meteorites have been made with He, Ne, and Ar. However, the data on the distribution of the nuclides with a mass number near that of the target, such as Ti, V, Cr, and Mn, are much more helpful in estimating the preatmospheric size and erosion rate of the meteorite in space. The results on the distribution of the cosmogenic nuclides of K, Ca, Ti, V, Cr, and Mn in the Grant meteorite are described. (W.D.M.)

5039 STUDY OF HELIUM ISOTOPIC ABUNDANCE IN THE SAMPLES WITH SMALL HELIUM CONTENT. Alimova, I. A.; Mamyrin, B. A.; Gartmanov, V. N.; Boltenkov, B. S. (Ioffe Inst. of Physics and Tech., Leningrad). pp 652-3 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

A very brief description is given of helium isotope analysis of air, meteorites, cosmic dust, aluminum, and mineral samples. (W.D.M.)

5040 MASS SPECTROGRAPHIC DETERMINATION OF TRACE ELEMENTS IN METEORITES. Hintenberger, H.; Berghof, W. (Max-Planck-Institut fuer Chemie, Mainz). pp 657-65 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The rare earth elements as well as the heavy elements Re, Os, Ir, Pt, Au, Tl, Pb, Bi, Th, and U were determined by spark source mass spectroscopy in the olivine–hypersthene chondrites Holbrook and Mocs and in the enstatite chondrite Abee. The rare earth elements were also measured in silicate inclusions of the iron meteorite El Taco. Compared to the rare earths in ordinary chondrites a strong depletion of europium was found in the El Taco inclusions. (auth)

5041 STABLE CARBON-ISOTOPE RATIOS IN METEORITIC ORGANIC MATTER. Flory, D. A. (Manned Spacecraft Center, Houston, Tex.). pp 692-9 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The measurement of stable carbon-isotope ratios of genuinely indigenous carbon-containing matter can shed new light on the admixture theory versus the successive-metamorphism theory of carbonaceous chondrite evolution. Successive metamorphism would result in isotope fractionation by preferential vaporization as the total carbon content decreases by the volatilization of organic carbon and would tend to produce material with only slight differences (about one percent) in isotopic composition for all carbon-containing phases. However, an admixture would retain any isotopic content variations in discrete phases and would show no correlation between isotopic composition and carbon content. For this report, carbon-isotope composition data were obtained for the total carbon present, the inorganic carbon fraction, the carbonate carbon fraction, and the insoluble organic carbon fraction. The extractable organic carbon fraction was not considered. Investigations conducted to determine the nature of the extractable organic carbon fraction concluded that the source is terrestrial contamination. The results of a recent study of the stable carbon-isotope composition of the soluble organic carbon in several carbonaceous chondrite meteorites carried out in the University of Houston biophysical science laboratories are also consistent with the conclusion of a terrestrial contamination source. (auth)

5042 EXTINCT ^{129}I, ^{244}Pu, AND SUPERHEAVY ELEMENTS IN THE EARLY HISTORY OF THE SOLAR SYSTEM. York, Derek (Univ. of Toronto). Comments Earth Sci., Geophys.; 2: No. 1, 14-21(Jun-Jul 1971).

A brief review is given on the existence of the extinct isotopes ^{129}I and ^{244}Pu and their implications for an understanding of the early solar system. 30 references. (W.D.M.)

Stars

Refer also to abstracts 5198, 5204, 5344, and 5482.

5043 LITHIUM ISOTOPE RATIO IN F AND G FIELD STARS. Cohen, Judith Gamora. Pasadena, Calif.; California Inst. of Tech. (1971). 220p. University Microfilms Order No. 71-27,095.

Thesis.

Theoretical profiles of the resonance line of Li I were computed using an absorption coefficient (sum of each of the four components) and a model stellar atmosphere. These profiles were used to verify the lithium abundances derived by previous investigators with various approximations. A study of the feasibility of measuring the lithium isotope ratio with high-dispersion photographic spectra was made, with negative results. Profiles were obtained of λ6708 Å of Li I, λ6717 Å of Ca I, and sometimes λ6710.3 Å of

Fe I, and the D lines of Na I for a selected group of F, G, and early K field stars. These profiles were observed from the Fabry–Perot interferometer at the coudé focus of the 100″ telescope with a resolution of 0.06 to 0.09 Å. Extensive checks of the accuracy of the wavelength scale, the instrumental profile, and the parasitic light level were made, including observations of the lunar spectrum. The D-line profiles were used to test the accuracy of the computed theoretical profiles. The observed stellar line profiles were fit by calculated ones to determine the lithium abundance, calcium abundance, rotational velocity, radial velocity, microturbulent velocity, and lithium isotope ratio for the program stars. The rotational velocities were all greater than 2 km/sec, and ranged up to 10 km/sec. The microturbulent velocities in the program stars must be greater than zero. The isotope ratio $^6Li/^7Li$, determined by two independent methods, was zero in all the stars, with the possible exception of χ' Ori, for which $^6Li/^7Li = 0.1$ (±0.1). (Diss. Abstr. Int., B)

5044 THEORIES OF STAR FORMATION. McNally, D. (London Univ.). Rep. Progr. Phys.; 34: No. 2, 71-108(1971).

Since stars must be forming at the present phase of galactic evolution, it is pertinent to investigate what conditions favor star formation. Observational evidence for the pre-main-sequence phase of stellar evolution is entirely absent, apart from that obtained about a single class of proto-stellar objects—the T-Tauri stars. Most theories of star formation require stars to form from the interstellar gas. The existing knowledge of the interstellar gas is not sufficient to define the initial conditions for star formation precisely. However, recent theoretical and observational studies are forcing a radical revision of interstellar concepts. Theoretical studies suggest that interstellar gas clouds may well be transient phenomena and that continuous variation of interstellar conditions may be expected. The observational studies have shown that the previously accepted enumeration of interstellar species may well be far from complete. Four major groups of star formation theory are identified. These deal with formation by collapse under gravity, by random accretion, by condensation, and by processes associated with the activity of galactic nuclei. Considerable attention is given to the theory of collapse under gravity since this is regarded as the major theory of star formation on the ground that its conceptional framework is better defined than that of the others. It is also a theory capable of further specific investigation. It is, however, pointed out that no theory of star formation can be regarded as definitive and that each group of theories has significant contributions to make to a subject where the essential problems—though simple in conception—may not be well posed. (auth) (UK)

5045 N III AND C III EMISSION IN Of STARS. Nussbaumer, H. (Univ. of Colorado, Boulder). Astrophys. J.; 170: No. 1, 93-108(15 Nov 1971).

As in Of stars the lines of N III $3p\ ^2P^0-3d\ ^2D$ λλ4634, 4641, 4642 are always in emission, one has in the past been looking for special excitation mechanisms. With $3d\ ^2D \rightarrow 3p\ ^2P^0$ in emission it also seemed strange that the most obvious decay $3p\ ^2P^0 \rightarrow 3s\ ^2S$ through λλ4097, 4103 does not produce emission lines. Population of $3d\ ^2D$ and $3s\ ^2S$ by absorption of continuous radiation and decay of $3p\ ^2P^0$ mainly by two-electron transitions to terms other than $3s\ ^2S$ can explain this puzzle. Population of $3d\ ^2D$ through the Bowen mechanism is shown to be improbable. The possibility of exciting $2s3d\ ^1D$, the upper level of C III λ5696, by photoionization of $2s^23d$ by He II λ304 or indirectly by resonance absorption of N IV λ322.57 is examined and ruled out as ineffective. Calculations taking into account effects of optical depth predict C III λ5696 to be in emission but the triplet at λ4649 to be in absorption without having to stipulate an extended atmosphere. (auth)

5046 ANALYSIS OF THE IRON SPECTRUM OF FOUR CEPHEIDS. Schmidt, Edward G. (Univ. of Arizona, Tucson). Astrophys. J.; 170: No. 1, 109-29(15 Nov 1971).

The iron spectra of four classical Cepheids, η Aql, U Sgr, S Nor, and Y Oph, were analyzed using both the curve of growth method and model atmospheres. The coarse curve of growth analysis was carried out with three sets of oscillator strengths, and systematic differences which depend on temperature were found. A comparison of the fine analysis with the curve of growth showed consistency when correct oscillator strengths were used. In view of this result, density variations derived from coarse analyses for Cepheids are not to be trusted. The four Cepheids analyzed were found to have identical abundances. In two of the stars, U Sgr and Y Oph, the effective gravities derived were nearly constant over the cycle while in the other two there were large increases in the spectroscopic gravities during part of the cycle. (auth)

5047 NONLINEAR MOTIONS OF ROTATING GASEOUS ELLIPSOIDS. Fujimoto, M. (Columbia Univ., New York). Astrophys. J.; 170: No. 1, 143-52(15 Nov 1971).

Nonlinear equations of motions of a rotating ellipsoid of viscous uniform gas are derived. The problem is made tractable by introducing a somewhat special but reasonable formula for the viscosity of the gas, and the general behavior of the ellipsoid is discussed. Once the ellipsoid is deformed as $a_1 > a_2 > a_3$ (say), where a_1, a_2, and a_3 designate the lengths of the semiaxes of the ellipsoid, its subsequent figures remain so until the oscillation is damped completely. In finite-amplitude oscillations, the viscous stresses prevent the ellipsoid from becoming elongated rapidly. The total circulation of gas does not always decay monotonically, but grows depending on the configuration of the ellipsoid. Perturbations of the toroidal modes are applied to axisymmetric ellipsoids initially, and numerical integrations of the nonlinear equations are carried out. Growing oscillations and secular deformations of the Maclaurin spheroid beyond the classical point of bifurcation are demonstrated. Dynamical evolution and rapid gravitational collapse of gaseous ellipsoids in free precession are also followed numerically. The large-amplitude oscillations after the first bounce amplify an initially small precession, performing upside-down motions of the ellipsoidal figure. (auth)

5048 EVOLUTION OF A 0.6-SOLAR-MASS WHITE DWARF. Vila, Samuel C. (Univ. of Pennsylvania, Philadelpha). Astrophys. J.; 170: No. 1, 153-6(15 Nov 1971).

The evolution of a 0.6 $M_\odot$ white-dwarf star composed of an oxygen core and a helium envelope was calculated. The calculations took into account the outer convection zone and the effect of the ion lattice on the specific heats. It was found that the star can become an invisible black dwarf in an interval of the order of 7×10^9 years, which is less than the present estimates of the age of the Universe. (auth)

5049 BRIGHT MEMBERSHIP OF THE GLOBULAR CLUSTER NGC 6838. Sanders, W. L. (Yerkes Observatory, Williams Bay, Wis.). Astron. Astrophys.; 15: No. 2, 173-8(Dec 1971).

Probabilities of membership, based on relative proper motions, for 401 stars in the field of NGC 6838 are given. To an estimated plate limiting magnitude of about 15 visual, 81 probable members are found over a field of 38′ × 31′. (auth)

5050 SECULAR STABILITY. II. AN ANALYTIC DISCUSSION OF THE ONSET OF COMPLEX ROOTS. Aizenman, M. L.; Perdang, J. (Univ., Liege). Astron. Astrophys.; 15: No. 2, 200-5 (Dec 1971).

The secular spectrum, and more specifically the occurrence of complex roots in this spectrum, was investigated by means of a perturbation technique. It was found that a dimensionless parameter controls the onset of complex eigenvalues, and it is the coefficient of radiative heat transport which plays the dominant role in this phenomenon. (auth)

5051 ROLE OF MAGNETIC FIELDS IN Ap STARS. Strittmatter, P. A. (Inst. for Theoretical Astronomy, Cambridge, Eng.); Norris, J. Astron. Astrophys.; 15: No. 2, 239-50(Dec 1971).

Evidence is presented in favor of the hypothesis that the abundance peculiarities in Ap stars are confined to the surface layers. The effects of rotational circulation, convection, accretion, and mass loss on surface peculiarities are considered. The existence of a zone in the gravity-effective temperature plane within which surface peculiarities can occur is demonstrated and its boundaries shown to agree satisfactorily with the observational evidence. In general, however, a substantial surface magnetic field is required if surface peculiarities are to be preserved even in this region. It is suggested that evolution to the Ap state depends on the initial ratio of magnetic to rotational energy. If this exceeds a critical value, field lines remain above the surface and magnetic braking occurs through a centrifugal wind. Angular momentum is lost on a time scale 10^7 to 10^9 years after which the centrifugal wind ceases and surface abundance peculiarities can be established by gravitational diffusion processes as suggested by Michaud. The model accounts naturally for a number of observed properties of the Ap stars, in particular their magnetic field strengths, slow rotation, and tendency to appear near the turnoff point in clusters. The process would also lead to the existence of patches of peculiar composition over the stellar surface, thus providing a possible explanation for the spectrum variables. Major difficulties with the abundances of heavy elements remain. (auth)

5052 DETECTION OF BLACK HOLES. Leibovitz, C.; Hube, D. P. (Univ. of Alberta, Edmonton). Astron. Astrophys.; 15: No. 2, 251-5(Dec 1971).

It is shown that in principle the gravitational lens effect may lead to significant light variations when a collapsed object such as a black hole passes between the observer and a normal star. Light curves characteristic of such an event are computed, and the possibility of observing such an event is discussed. (auth)

5053 OPACITY PROBABILITY DISTRIBUTION FUNCTIONS FOR ELECTRONIC SYSTEMS OF CN AND C_2 MOLECULES INCLUDING THEIR STELLAR ISOTOPIC FORMS. Querci, F. (Univ. of California, Berkeley); Querci, M.; Kunde, V. G. Astron. Astrophys.; 15: No. 2, 256-74(Dec 1971).

The basis and techniques are presented for generating opacity probability distribution functions for the CN molecule (red and violet systems) and the C_2 molecule (Swan, Phillips, Ballik–Ramsay systems), two of the more important diatomic molecules in the spectra of carbon stars, with a view to including these distribution functions in equilibrium model atmosphere calculations. Comparisons to the CO molecule are also shown. The computation of the monochromatic absorption coefficient uses the most recent molecular data with revision of the oscillator strengths for some of the band systems. The total molecular stellar mass absorption coefficient is established through fifteen equations of molecular dissociation equilibrium to relate the distribution functions to each other on a per gram of stellar material basis. (auth)

5054 SPECTRUM OF ζ PUPPIS (O5f). Baschek, B.; Scholz, M. (Univ., Heidelberg). Astron. Astrophys.; 15: No. 2, 285-91(Dec 1971).

New observations of the line spectrum of ζ Pup (O 5f) from λ 3150 to λ 8600 are presented. The absorption spectrum is similar to that of 9 Sgr (O 5). There are, however, features that point to a later and others that point to an earlier spectral type than 9 Sgr. The emission spectrum shows deviations from typical Of type spectra, e.g., C_{III} 5696 is absent, and C_{IV} 5802–12 appears in emission. The existence of a much fainter secondary Wolf–Rayet component cannot completely be ruled out. The effective temperature derived from the absorption line spectrum, $T_{eff} \approx 50{,}000°$, is considerably higher than $T_{eff} = 31{,}000 \pm 2500°$ deduced from the interferometric diameter measurement of Davis et al. (1970). It is suggested that this discrepancy is reduced if effects of rapid rotation and, possibly, of interstellar absorption are taken into consideration. (auth)

5055 ORBITAL ELEMENTS OF THE SPECTROSCOPIC BINARY HD 201359. Acker, A. (Observatoire, Strasbourg). Astron. Astrophys.; 15: No. 2, 304-5(Dec 1971). (In French).

The orbital elements of HD 201359 were determined from 11 observations, made with 3 spectrographs, between 1968 and 1969. (auth)

5056 LIGHT CURVES AND PERIOD VARIATION OF DT Cyg AND T Vul. Johansen, K. T. (Copenhagen Univ. Observatory, Brorfelde, Den.). Astron. Astrophys.; 15: No. 2, 311-19 (Dec 1971).

Photoelectric observations of the Cepheid variables DT Cyg and T Vul were obtained in B and V. The period variation of DT Cyg was studied using all available observations of the light curve, and the variability of the period was confirmed. Using observations later than J. d. 2410500 T Vul was investigated. No variation of the period could be detected. (auth)

5057 SIX-COLOR PHOTOMETRY OF 13 F–G SUPERGIANTS IN THE LARGE MAGELLANIC CLOUD. Brunet, J. P.; Mianes, P.; Perrin, M. N.; Prevot, L.; Rousseau, J. (Observatoire, Haute Provence, France. Observatoire, Lyon. Observatoire, Marseille. Observatoire Europeen Austral, Santiago). Astron. Astrophys.; 15: No. 2, 320-4(Dec 1971).

The application of six-color photometry to the study of 13 F–G supergiants among the most luminous stars of the LMC shows their colors are not obviously different from galactic stars of the same luminosity. The plot V – G, G – I displays a thermal locus for Ia supergiants which suffer a small amount of reddening. It is shown that six-color photometry does not indicate any distinction between Ia and Ib supergiants slightly reddened. Color indices of equatorial standard stars are also given. (auth)

5058 GLOBAL DYNAMICAL STABILITY OF ROTATING STARS. Fricke, K. J. (Univ., Goettingen, Ger. Inst. of Theoretical Astronomy, Cambridg, Eng.); Smith, R. C. Astron. Astrophys.; 15: No. 2, 329-31(Dec 1971).

The local criteria for axisymmetric dynamical stability of rotating stars are shown to be globally valid by the use of a variational principle. These criteria are necessary and sufficient so long as the perturbation of the gravitational potential can be neglected. (auth)

5059 GROUP OF PECULIAR STARS IN CENTAURUS. Loden, L. O. (Stockholm Observatory). Astron. Astrophys.; 15: No. 2, 332-3(Dec 1971).

A group of four apparently peculiar early-type stars were detected in Centaurus. According to color and Balmer line widths the spectral type would be approximately B6, but the spectra show both very strong helium lines and a strong K line that seems to be slightly variable. (W.D.M.)

5060 COMMENTS ON THE BROADENING OF He I LINES WITH FORBIDDEN COMPONENTS. O'Mara, B. J.; Simpson, R. W. (Univ. of Queensland, Brisbane). Astron. Astrophys.; 15: No. 2, 334-6(Dec 1971).

A comparison between the observed and theoretical absorption profiles of the neutral helium lines λ4471 and λ4026 was carried out for the B0V star τ Sco for those parts of the line where deviations from local thermodynamic equilibrium are unimportant. The result for the λ4471 line was essentially the same as that obtained by Burgess and Cairns (1970) and Birkeland et al. (1971), in that the flux in the line wings agreed quite well but there was considerable discrepancy between the theoretical and observed values of the flux near the peak of the forbidden component. The agreement between theory and observation was better for the λ4026 line which lends weight to the suggestions put forward by Burgess (1970) concerning the incorrect treatment of the ion broadening of the forbidden component in existing theories. (auth)

5061 ULTRARAPID ACTIVITY AT Hα IN SPECTRA OF Be STARS. Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.); Auman, J. R.; Gower, A. C.; Walker, G. A. H. Astrophys. J.; 170: No. 2, L73-6(1 Dec 1971).

High-resolution spectra of some Be stars, taken with an Isocon television camera, show changes in the Hα line profile in times of the order of a minute or less. (auth)

5062 NUCLEOSYNTHESIS DURING ADVANCED BURNING STAGES OF STARS (VOLUMES I AND II). Woosley, Stanford Earl. Houston, Tex.; Rice Univ. (1971). 363p. University Microfilms Order No. 71-26,378.

Thesis.

The nuclear processing which occurs in the interior zones of highly evolved (presupernova) stars is considered in detail. At the high temperatures and densities encountered ($T > 1.5 \times 10^9$ °K, $\rho > 1 \times 10^5$ g cm^{-3}) a great variety of both strong and weak interactions lead to nuclear "flows" from one element to another. A linearized approximation to the actual differential equations of flow has been incorporated into a generalized computer code which can follow the nuclear evolution for any number of species for which cross-section information is furnished. This code has been used to follow the evolution of stellar zones undergoing hydrostatic oxygen burning and the explosive burning of oxygen and silicon. Various simplifying approximations were determined to give a clearer view into the dominant processes. In this regard the concept of a "local equilibrium" or nuclear "quasi-equilibrium" was found to be a powerful tool. If one demands that the solar abundance distribution of the elements in the mass range $28 \leq A \leq 62$ be synthesized in supernova explosions, then the results of these nucleosynthesis calculations can be employed to place restrictions on supernova models. Cross sections that may have considerable effect upon the nucleosynthesis were tabulated. (Diss. Abstr. Int., B)

5063 OBSERVATION OF NOVA CEPHEI 1971. Fehrenbach, C.; Andrillat, Y. (Centre National de la Recherche Scientifique, Marseille). Compt. Rend., Ser. B; 273: No. 13, 572-6(27 Sep 1971). (In French).

The main features of twenty spectra of Nova Cephei 1971 obtained since July 14, 1971 are described. The spectral range considered is 3,400 to 9,600 Å. (France)

5064 INFRARED SPECTRA OF LATE-TYPE STARS. Frogel, Jay Albert. Pasadena, Calif.; California Inst. of Tech. (1971). 272p. University Microfilms Order No. 71-26,127.

7 Thesis.

Spectra were obtained in the 2μ atmospheric window with a resolution of 32 and 65Å of late-type dwarfs, giants, supergiants, and long-period variables. In the nonvariable stars, the first overtone band of CO at 2.29μ showed a systematic increase with both increasing luminosity and decreasing temperature. Variations in the strengths of the H_2O and CO bands were measured in 18 long-period variables as well as variations in the continuum flux at 2.25 μ, f(225). There was evidence for differences in the value of [O/C] among the variable stars. NML Tau seems to have a value similar to that of U Ori, a typical M-type variable. R Aur, T Cas, χ Cyg, and RS Lib appear to have abnormally low values of [O/C]. A model involving the motion of a shock wave through the star's atmosphere is discussed as a possible means of explaining variations in both visual and infrared spectra. The evolutionary history of and the effect of convective mixing in late-type stars is discussed and it is concluded that: (1) the value of $[C^{12}/C^{13}]$ indicates that mixing has occurred; (2) the degree of mixing may be greater in the nonvariables than in the variables; and (3) the observations are not inconsistent with a high value of [O/C] in most of the stars observed, i.e., [O/C] ~ 2. (TSS) (Diss. Abstr. Int., B)

5065 CARBON-RICH STARS WITH HELIUM ENVELOPES. Joss, Paul Christopher. Ithaca, N. Y.; Cornell Univ. (1971). 149p. University Microfilms Order No. 71-25,161.

Thesis.

The evolution of stellar models with masses between $0.75M_\odot$ and $1.37M_\odot$ was investigated. The models had cores comprised of 50% ^{12}C and 50% ^{16}O by mass, and envelopes comprised of pure helium. A sequence of $1.37M_\odot$ models with initial helium envelopes of 5.5%, 21%, 32%, and 50% was calculated. After a period of steady helium shell-burning, the model with 21% envelope ignited carbon in a convective shell. This was followed by a convective core-burning phase, which was in turn followed by a series of secondary convective shell-flashes. Finally, the remaining helium envelope again distended greatly, and the evolutionary calculations were terminated. The helium envelopes also distended after a period of steady helium shell-burning in the models with 32% and 50% envelopes. It is unclear as to whether carbon would ignite during the subsequent evolution of these models. In all the above cases, the helium-burning shells were thermally and radiatively stable. The evolutions of a $0.75M_\odot$ model with a 5.5% initial helium envelope, and of a sequence of $1.02M_\odot$ models with 0%, 2.3%, and 5.5% initial helium envelopes were calculated. The sense of evolution of the low-mass ($M \leq 1.02M_\odot$) models on the Hertzsprung–Russell diagram is the same as that of the nuclei of planetary nebulae. The evolutionary time scale of the $0.75M_\odot$ model is too long to fit the time-scale of evolution of the observed nuclei ($\sim 3 \times 10^4$ years), but the time scales of the $1.02M_\odot$ models do fit the observations. For the latter models, the maximum luminosity increases with increasing helium envelope. The maximum luminosities of the models with no envelope and 2.3% envelope were $\approx 5 \times 10^3$ $L_\odot$ and $\approx 2 \times 10^4$ $L_\odot$, respectively, compared with $\sim 10^4$ $L_\odot$ for the observed nuclei. The surface temperatures of the models were too large to fit the observations; however, the inclusion of an outer hydrogen-rich envelope of small mass fraction would lower the surface temperatures of the models. (TSS) (Diss. Abstr. Int., B)

5066 STUDIES OF HYDRODYNAMICAL AND RADIATIVE TRANSFER EFFECTS IN RR LYRAE ATMOSPHERE. Hill, Stephen James. Boulder, Colo.; Univ. of Colorado (1971). 173p. University Microfilms Order No. 71-25,835.

Thesis.

Successful models of RR Lyrae stars have been produced which have duplicated the pulsational instability which is observed to be characteristic of these stars. These models have neglected the bulk of the atmosphere above the photosphere. This small fraction of the star is of importance because it is the layer of the star that is observed. To understand the action of the pulsating atmosphere, a series of modeling techniques were employed in a computer numerical solution. (TSS) (Diss. Abstr. Int., B)

5067 EVOLUTION OF SINGLE STARS. IV. HELIUM STARS. Paczynski, B. (Cambridge Univ., Eng.). Acta Astron.; 21: No. 1, 1-14(1971).

Model calculations, with and without neutrino emission, were made for helium stars of masses 0.5, 0.7, 0.85, 1.0, 1.5, 2.0, 4.0, 8.0 and 16.0 $M_\odot$ evolving through the core-He and core-C burning phases. The effective temperatures of the heavier models ($M \geq 8$ $M_\odot$) were never below $10^{5°}$K. With neutrino emission, only the 1- and 5-$M_\odot$ models could evolve to the red supergiant region; these models were identified with R CrB variables. (W.D.M.)

5068 PRAKTICHESKIE RABOTY PO ZVEZDNOI ASTRONOMII. (Practical Articles on Stellar Astronomy). Kulikovskii, P. G. (ed.). Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 188p.

Nearly one-fourth of the manual is devoted to listing available stellar catalogs, maps, and atlases published in English and German. Successive chapters are chiefly devoted to determinative methods for: proper stellar motions, stellar magnitudes, orbits of visual double stars, continuous spectra, light absorption by nebulae, and galactic parameters. (K.S.W.)

5069 MAGNETIC FIELD DECAY IN CONDENSED OBJECTS: THE INFLUENCE OF SPACE–TIME CURVATURE. Grewing, M. (Univ., Bonn); Heintzmann, H. Z. Phys.; 247: No. 3, 223-6(1971).

A generalization of Lamb's formula for the decay of a magnetic field due to ohmic dissipation is given, which takes into account the influence of space–time curvature. It is found that, for condensed objects such as heavy neutron stars, the decay time for the magnetic field is substantially lengthened. (auth)

5070 MATTER IN SUPERSTRONG MAGNETIC FIELDS: THE SURFACE OF A NEUTRON STAR. Ruderman, M. (Columbia Univ., New York). Phys. Rev. Lett.; 27: No. 19, 1306-8 (8 Nov 1971).

In superstrong magnetic fields ($B \gtrsim 10^{12}$ G) matter forms a tightly bound, dense ($\gtrsim 10^4$ g cm^{-3}) solid with properties of a one-dimensional metal and a work function of the order of a keV. Electron field emission from the sharp surface of a pulsar is much easier than ion emission; it is estimated to be cut off when the stellar rotation period exceeds several seconds. (auth)

5071 MASS AND CHEMICAL COMPOSITION OF CASSIOPEIA A. Peimbert, Manuel (Univ. de Mexico, Mexico City. Observatorio, Tonantzintla, Mexico). Astrophys. J.; 170: No. 2, 261-3(1 Dec 1971).

The mass and chemical composition of the moving knots in Cassiopeia A were estimated from new photoelectric observations by Searle. (auth)

5072 RELAXATION TIME IN CLUSTERS WITH PAIR CORRELATIONS. Butterworth, E. Manning; Miller, Richard H. (Univ. of Chicago). Astrophys. J.; 170: No. 2, 275-6(1 Dec 1971).

The results are described of numerical experiments on relaxation times in stellar clusters whose members have a deliberately introduced pair correlation. Pairs behaved on the average as single stars, even though members of correlated pairs were separated at least as far as the mean distance between nearest neighbors as measured in clusters with no pair correlation. (auth)

5073 LOWER LIMIT TO THE INTERSTELLAR $^{12}C/^{13}C$ RATIO IN THE DIRECTION OF 20 TAURI. Vanden Bout, P. (Univ. of Texas, Austin); Thaddeus, P. Astrophys. J.; 170: No. 2, 297-8(1 Dec 1971).

The spectrum of 20τ was photoelectrically scanned in the vicinity of λ4232 of interstellar CH^+. From the observed absence of the isotopically-shifted line of $^{13}CH^+$ it was deduced that the $^{12}C/^{13}C$ isotopic abundance ratio in this direction is greater than 33, and hence consistent with the terrestrial value. (auth)

5074 GROUND STATE OF MATTER AT HIGH DENSITIES: EQUATION OF STATE AND STELLAR MODELS. Baym, Gordon; Pethick, Christopher; Sutherland, Peter (Univ. of Illinois, Urbana). Astrophys. J.; 170: No. 2, 299-317(1 Dec 1971).

The equation of state of zero-temperature matter in complete nuclear equilibrium is given for mass densities below 5×10^{14} g cm^{-3}. Taking into account the effect of the Coulomb lattice and using more recent nuclear mass extrapolations, the sequence of equilibrium nuclides present at mass densities between 10^4 and 4.3×10^{11} g cm^{-3}, the point of neutron drip, was redetermined; and the equation of state was calculated. For densities between 4.3×10^{11} and 5×10^{14} g cm^{-3} the equation of state is taken from the calculations of Baym, Bethe, and Pethick; included is an extension of the equation of state to still higher densities, taken from the calculations of Pandharipande, which include the effects of hyperons. Zero-temperature white-dwarf and neutron-star models were calculated for the equation of state. The maximum stable white-dwarf mass, the Chandrasekhar limit, is 1.00 $M_\odot$. The lightest stable neutron star has a mass 0.0925 $M_\odot$ and a central density 1.55×10^{14} g cm^{-3}; neutron stars between 0.0925 and 0.11 $M_\odot$ are entirely solid. Moments of inertia, surface deformations, and mass quadrupole moments were calculated for slowly rotating neutron stars. (auth)

5075 THEORY OF STELLAR WINDS. Durney, B. R.; Roberts, P. H. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 170: No. 2, 319-23(1 Dec 1971).

It has been recently shown by Roberts that solutions of the stellar wind equations depend essentially on a single parameter $K = \frac{1}{2} A\epsilon_\infty^{\frac{1}{2}}$, where ϵ_∞ is the (dimensionless) residual energy per particle at infinity and A is a nondimensional constant proportional to the reciprocal of the mass flux C. This transformation makes it a comparatively simple matter to examine solutions for a wide variety of A and ϵ_∞. The calculations reported are for the range $75 < K < 2000$, which covers many cases of astrophysical interest. (auth)

5076 SPECTROSCOPIC STUDIES OF O-TYPE STARS. I. CLASSIFICATION AND ABSOLUTE MAGNITUDES. Conti, Peter S.; Alschuler, William R. (Univ. of California, Santa Cruz). Astrophys. J.; 170: No. 2, 325-44(1 Dec 1971).

Spectrograms with dispersions of 16 Å mm^{-1} were used to determine the spectral classification of 130 O-type stars. Intermediate MK types, e.g., O7.5, by measures of the He I and He II line strengths and a luminosity classification for the later O-type stars which involves measures of the ratio of Si IV to (singlet) He I were introduced. About fifty O-type stars have absolute magnitudes obtainable from membership in clusters and associations which have "well established" distances. These stars enable one to calibrate the luminosity criteria in terms of M_v. Of stars were defined as those in which the N III multiplet at λλ4634, 4640, 4641 is in emission above the continuum. Using only those O stars with known distances, it was found that the Of stars are exclusively in the hotter and brighter part of the H–R diagram. Although all O6 stars and earlier are Of, only the brighter later type O stars show these emission lines. Calibration of M_v with the spectral type and Of characteristics is provided for the O stars. The presence of these lines in emission is suggested to be due to extended, possibly

expanding, envelopes around these luminous stars. The He II 4686 line also appears in emission in some Of stars; there is a general tendency for the strength of this emission to be dependent on luminosity and effective temperature. (auth)

5077 VARIATIONS IN BETA CEPHEI STARS. Watson, R. D. (Australian National Univ., Canberra). Astrophys. J.; 170: No. 2, 345-51(1 Dec 1971).

Three-color light-curve observations of a number of β Cephei stars are reported, together with some observations using a H_γ filter. The large observed $2K/\Delta m$ ratio of the β Cephei stars is discussed. It is concluded that, while nonradial motion may be present in the β Cephei stars, the large $2K/\Delta m$ value cannot necessarily be used as an argument to support this hypothesis. At least for the observed variables which are not amplitude modulated, the ranges of light, color, and radial velocity appear consistent with a radial model. (auth)

5078 FIVE-SOLAR-MASS EVOLUTION FOR POPULATION I COMPOSITIONS. Robertson, J. W. (Australian National Univ., Canberra). Astrophys. J.; 170: No. 2, 353-62(1 Dec 1971).

Stellar models of $5M_\odot$ have been evolved from the initial main sequence through the bluest point of the loops during core helium burning for the three (X, Y, Z) compositions: (0.602, 0.354, 0.044), (0.708, 0.272, 0.02), and (0.617, 0.363, 0.02). Convective overshooting of the helium-burning core and helium–carbon–oxygen semiconvection are included in the evolution. The loops become longer and brighter as Y is increased or Z is decreased. With the inclusion of core convective overshooting, the loops become longer and more time is spent near the blue end of the loops. (auth)

5079 EVOLUTION OF LOW-MASS STARS. IV. EFFECTS OF MULTILEVEL ATOMIC PARTITION FUNCTIONS FOR THE IDEAL-GAS REGION. Graboske, H. C. Jr. (Univ. of California, Livermore); Grossman, A. S. Astrophys. J.; 170: No. 2, 363-70(1 Dec 1971).

Several improvements were introduced in the theory of equilibrium thermodynamic properties for densities and temperatures appropriate to evolution of low-mass stars. Effects of these modifications were investigated for stars in the mass range 0.03 to 0.2 $M_\odot$. In the ideal-gas region, inclusion of the excited states in the atomic partition functions causes the early pre-main-sequence and deuterium-main-sequence models to shift toward lower T_e and L, an effect which increases as stellar mass increases. Modification of the Coulomb interaction free energy causes the late pre-main-sequence and hydrogen-main-sequence models to shift toward lower T_e and L, an effect which increases with decreasing stellar mass. The 0.085 $M_\odot$ star reaches a stable hydrogen-main-sequence phase in 2.4×10^9 years, but the occurrence of the central-temperature maximum before the main-sequence phase is attained indicates that 0.085 $M_\odot$ is very close to the critical mass at this composition. The estimate of the mass of van Biesbroeck's star (VB 10) is revised from 0.03 $M_\odot$ to close to 0.085 $M_\odot$ based on recent determinations of T_e and $L/L_\odot$ for this star. (auth)

5080 PHOTOIONIZATION CROSS SECTIONS FOR HELIUM-LIKE POSITIVE IONS. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.). Astrophys. J.; 170: No. 2, 387-91(1 Dec 1971).

The photoionization cross section for a two-electron atomic system was calculated with a two-parameter variational bound-state wave function and a Coulomb continuum wave function. The relatively simple closed-form expression obtained gives numerical results for He I and Li II that lie within or very near the envelope of curves resulting from much more elaborate calculations. (auth)

5081 BETA DECAY OF ^{187}Re INTO BOUND STATES FOR STELLAR CONDITIONS. Perrone, Frank Anthony. Houston, Tex.; Rice Univ. (1971). 50p. University Microfilms Order No. 71-26,340.

Thesis.

The $^{187}Re/^{187}Os$ abundance ratio implies an awkwardly long galactic age when applied to the exponential model of galactic nucleosynthesis. ^{187}Re has a measured beta-decay half-life of $\approx 4 \times 10^{10}$ years. An investigation was made exploring the possibility of a faster decay rate into unoccupied bound states for ionized ^{187}Re at stellar temperatures and densities. A formula for the bound state beta-decay rate of allowed transitions was adapted to the first-forbidden unique transition of ^{187}Re. Certain approximations were made concerning the atomic energy levels and atomic wave functions for varying degrees of ionization. Finally, the Saha equation was used to give the total ^{187}Re beta-decay half-life for various temperatures and free-electron densities. The solar convective zone is not capable of decreasing the $^{187}Re/^{187}Os$ ratio. Stars with masses $15\ M_\odot > M \gtrsim 7\ M_\odot$ are able to effectively decrease the ^{187}Re half-life to $\approx 10^9$ years so as to explain the $^{187}Re/^{187}Os$ abundance ratio. (Diss. Abstr. Int., B)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 5221 and 5900.

5082 SOFT X RAYS FROM NONTHERMAL GALACTIC RADIO SOURCES: IMPLICATIONS CONCERNING THE GALACTIC BACKGROUND AND THE INTERSTELLAR MEDIUM. Ilovaisky, S. A.; Ryter, Ch. (Institut d'Astrophysique, Paris. CEN de Saclay, Gif-sur-Yvette, France). Astron. Astrophys.; 15: No. 2, 224-34(Dec 1971).

Using presently available data on soft x-ray emission from supernova remnants (SNR) with known distances, empirical correlations were found between the intrinsic luminosity (in the 0.2- to 1-keV band and at 0.27 keV) and the linear source diameter, which is an age parameter in the theory of SNR. Assuming all SNR discovered in radio surveys follow the correlations, their 0.27-keV flux densities at Earth were computed allowing for absorption in a clumpy interstellar medium. The source distances were taken from a recent discussion of SNR by Ilovaisky and Lequeux (1971). It was found that nearby discrete sources can account for the residual 0.27-keV fluxes observed near the plane and frequently assumed to be due to a diffuse effect. Selection effects present in the radio surveys were taken into account and showed that, within 2 kpc of the Sun, the available SNR sample is only 25% complete in the diameter interval 35 pc $\leq D \leq$ 60 pc, a fact which does not facilitate the interpretation of galactic soft-x-ray data. An evaluation of the power input into the interstellar medium due to x rays between 0.2 and 1 keV emitted from SNR was made using the corrected number–diameter function, proper galactic distribution parameters, and the luminosity–diameter correlation, all tacitly assumed valid up to $D \approx 100$ pc. It was estimated that the hydrogen ionization rate due to 0.2- to 1-keV photons can at best be $\langle \xi_H \rangle \approx 2\ 10^{-17}\ s^{-1}$. This fails to meet the required value needed for the heating and ionization of the interstellar medium by a factor >20. The maximum galactic luminosity in this energy band due to SNR is $L_x \approx 2\ 10^{39}$ erg s^{-1}. Coincidentally, it was found that the value due to all Sco–Sgr type sources in the same band is quite comparable. (auth)

5083 QUANTUM TREATMENT OF ELECTRON EMISSION IN A STRONG ELECTROMAGNETIC WAVE. Bonometto, S. A. (Cambridge Univ., Eng.). Astron. Astrophys.; 15: No. 2, 193-9 (Dec 1971).

The emission by electrons in a strong electromagnetic wave was studied by using quantum mechanics. The quantum treatment is given stressing the case in which the most probable number of photons of the wave, absorbed by an electron to emit one photon, is much greater than one. The applicability of quantum results to astrophysical situations is discussed, outlining the possibility that strong electromagnetic waves, emitted by pulsars according to several models, may need quantum treatment. Energy losses by electrons were studied in the quantum regime and the possible importance of electron pair production in the wave is stressed. (auth)

5084 PRECISE LABORATORY DETERMINATION OF ROTATIONAL TRANSITION FREQUENCIES IN CYANOACETYLENE. De Zafra, Robert L. (Goddard Space Flight Center, New York. Columbia Univ., New York). Astrophys. J.; 170: No. 1, 165-8 (15 Nov 1971).

The quadrupole coupling constant and rotational constants B_0 and D_J for the ground vibrational state of cyanoacetylene (HC_3N) were measured with high precision in the laboratory. Resulting values allow a more precise determination of interstellar HC_3N velocities, and simplify the identification of additional interstellar rotational transitions. (auth)

5085 ABSORPTION-LINE SPECTRUM OF 4C 05.34. Bahcall, John N.; Goldsmith, Samuel (California Inst. of Tech., Pasadena). Contracts AT(11-1)-68; GP-27565. Astrophys. J.; 170: No. 1, 17-24(15 Nov 1971).

Eight acceptable absorption redshifts were found in the spectrum of 4C 05.34 reported by Lynds. The absorption redshifts ranged from $z = 2.875$ to $z = 1.776$. An average nonsense spectrum has 1.4 acceptable redshifts. The absence of absorption from excited fine-structure states implies that the absorbing region has an electron density $\lesssim 10^2$ cm^{-3} and is at a distance $\gtrsim 1$ kpc from the continuum source of the QSO. (auth)

5086 FORMATION OF OH THROUGH INVERSE PREDISSOCIATION. Julienne, P. S. (National Bureau of Standards, Washington, D. C.); Krauss, M.; Donn, B. Astrophys. J.; 170: No. 1, 65-70(15 Nov 1971).

Formation of OH can occur by inverse predissociation from continuum levels to the $v = 1$, $k = 1$ level of the $A\ ^2\Sigma^+$ state. A rate constant of 1 to 3×10^{-20} $cm^3\ s^{-1}$ is calculated for temperatures greater than 20°K. Predicted OH densities are consistent with observations in dense, heavily obscured clouds but appear to be somewhat low for H I clouds. (auth)

5087 MEANING OF THE OH–H_{20} MASER MAPS. Litvak, M. M. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 170: No. 1, 71–80(15 Nov 1971).

The approximate conditions of density, diameter, and temperature of the OH and H_2O maser regions are deduced from the very long baseline interferometry, from the presence of microwave saturation, from the energy requirements, from the absence of excessive pressure or thermal broadening, from the microwave optical depths, and from the selection of hyperfine components. The amplifier surrounding each emission point has a diameter comparable to the distance between neighboring points and a mass close to 1 $M_\odot$. Calculations indicate that the nonlinear effect of self-focusing is probably not occurring, that stimulated Raman scattering is yielding only the lowest hyperfine component in H_2O with a line-shape asymmetry toward lower frequency, and that for both OH and H_2O the interferometers are observing "hot spots" of unsaturated amplification. Ordinary scattering from spatial fluctuations in electron density probably accounts for the observed angular sizes, especially for 18-cm OH signals. The region appears to consist of condensations each of about 1 $M_\odot$ on the edges of two parallel, slowly corotating disks, each about 100 $M_\odot$. A stable, large-scale rotational discontinuity (of velocity and magnetic field) may be propagating between the two disks. (auth)

5088 HIGH-FREQUENCY CONFIRMATION OF A RADIO RECOMBINATION LINE FROM AN H I REGION. Chaisson, Eric J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 170: No. 1, 81-4(15 Nov 1971).

The existence of a hydrogen recombination line arising from an H I region in the microwave spectrum of NGC 2024 was confirmed at 94α. Frequency dependence of the line radiation from the H I cloud differs significantly from that of the associated H II region. (auth)

5089 POSSIBILITY OF PULSAR ACTION IN QUASARS. Sturrock P. A. (Stanford Univ., Calif.). Astrophys. J.; 170: No. 1, 85–92(15 Nov 1971).

A recently proposed theory of pulsars is taken as a basis for evaluating Morrison's proposal that quasars may be giant pulsars. It is found that an object with mass $10^{43.4}$ g, radius $10^{16.5}$ cm, and magnetic field strength 10^4 gauss (Morrison's parameters) would not exhibit pulsar activity but would be an intense source of γ rays with luminosity exceeding 10^{48} ergs s^{-1}. Pulsar activity would occur if the field strength were $10^{5.1}$ gauss or more, but the lifetime would be only $10^{2.6}$ years. Most of the power (>10^{51} ergs s^{-1}) would be emitted as γ rays. One must conclude, on the basis of this theory, that quasars are probably not giant pulsars. There seems to be a much stronger similarity between quasars and the x-ray source Sco X-1 than between quasars and pulsars. (auth)

5090 X-RAY EMISSION FROM MAGELLANIC CLOUDS OBSERVED BY UHURU. Leong, C.; Kellogg, E.; Gursky, H.; Tananbaum, H.; Giacconi, R. (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 170: No. 2, L67-71 (1 Dec 1971).

Three sources in the Large Magellanic Cloud and one in the Small Cloud were discovered by Uhuru. These sources each emit about 10^{38} ergs s^{-1} in the 2 to 7-keV band, and they account for more than 90% of the total emission from the Clouds. The source in the Small Cloud shows time variability on time scales of hours. (auth)

5091 CIRCULAR POLARIZATION OF SOME PECULIAR OBJECTS. Nikulin, N. S.; Kuvshinov, V. M.; Severny, A. B. (Crimean Astrophysical Observatory, Moscow). Astrophys. J.; 170: No. 2, L53-8(1 Dec 1971).

Circular polarization of several peculiar objects (in particular, x-ray sources) was measured with the stellar magnetograph of the 104-inch Crimean reflecting telescope. Circular polarization $\geq 1\%$ is suspected in the nuclei of the Seyfert galaxies NGC 4151 and NGC 1068, and in the quasar 3C 273. Rapid variations of the amount and sense of circular polarization were observed in the x-ray source Sco X-1 with time scales of the order of 30 minutes. An appreciable effect was also detected in the nucleus of the planetary nebula +30°3639. (auth)

5092 INTERSTELLAR ABSORPTION OF THE CRAB NEBULA'S SOFT X-RAY FLUX AND THE X-RAY SPECTRUM OF THE CRAB PULSAR. Coleman, Philip Lynn. Madison, Wis.; Univ. of Wisconsin (1971). 152p. University Microfilms Order No. 71-20,660.

Thesis.

The results of a sounding-rocket observation of the Crab Nebula with x-ray detectors sensitive over the energy interval 0.1 to 12 keV are presented. On the assumption that the Crab's x-ray emission below 1.5 keV is a smooth extrapolation of its 1.5 to 10 keV spectrum, the data shows an attenuation of the flux below 1.5 keV due to absorption by the interstellar gas. In particular, this gas must have an optical depth of 0.14 ± 0.07 at 1 keV and an optical depth greater than 4.5 at 0.25 keV. The range of chemical compositions of the interstellar medium compatible with these results is significantly different from the usually assumed "cosmic" abundances. The data were also analyzed in terms of the emission due to the pulsar imbedded in the Crab Nebula. The intensity of the pulses relative to the continuous nebular radiation increases by a factor of two between 1 and 10 keV. A power-law spectrum of slope 1.55 ± 0.15 fits the pulsar data well. This spectral index is much smaller than the slope of 2.0 observed for the Crab as a whole at x-ray wavelengths. (Diss. Abstr. Int., B)

5093 FAR-INFRARED OBSERVATIONS OF GALACTIC H II REGIONS. Harper, Doyal Alexander Jr. Houston, Tex.; Rice Univ. (1971). 124p. University Microfilms Order No. 71-26,293.

Thesis.

The H II regions DR-21, K3-50, M17, M42, NGC 2024, W49, W51, and NGC 7027 were observed in the far infrared at wavelengths between 40 and 750 μ. Large fluxes were detected from all of the objects except the planetary nebula NGC 7027. The far-infrared luminosities ranged from 2×10^4 to 2×10^7 $L_\odot$. Measurements of M17, M42, NGC 2024, and W51 made with several different beam sizes and spectral passbands indicated that the sources are extended, optically thin, and have temperatures between 50 and 130°K. The far-infrared sources appear to be coincident with bright, compact, thermal radio sources, and the 40 to 750-μ flux is proportional to the high-frequency radio flux density. The fact that the observed 40 to 750-μ fluxes are substantially greater than can be accounted for by absorption of nebular Lyman α radiation by dust grains and/or infrared forbidden line radiation implies that dust may influence the structure and total energy balance of H II regions to a much greater extent than previously expected. The total mass of dust particles required to absorb a large fraction of the total luminosity of the hot, massive stars producing an H II region and re-emit the energy as far-infrared radiation is consistent with cosmic abundances and the mass of nebular H II gas calculated from the radio data. Thus it appears possible to explain the infrared emission in terms of thermal emission by dust present in the interstellar gas clouds from which the stars were formed. The absence of such a primordial dust and gas cloud could explain the failure to detect far-infrared emission from NGC 7027. More detailed and extensive far-infrared observations should prove crucial in understanding the nature of interstellar dust and the physical processes attending the formation and evolution of massive stars. (Diss. Abstr. Int., B)

5094 INTERSTELLAR GAS IN DIRECTION OF THE VELA PULSAR. Wallerstein, George; Silk, Joseph (Univ. of California, Berkeley). Astrophys. J.; 170: No. 2, 289-96(1 Dec 1971).

High-velocity interstellar Ca II components were found in two stars within three degrees of the Vela pulsar, 0833−45. One component, at −172 km s^{-1} relative to the local standard of rest, is believed to be the highest velocity hitherto observed in an interstellar absorption line. These lines appear to be associated with the Vela X, Y, Z, supernova-remnant complex. The measured velocity enables one to derive significant new limits on the age of the remnant and the initial kinetic energy associated with the supernova outburst, together with a self-consistent interpretation of the associated soft x-ray emission. (auth)

5095 ABSENCE OF FORMALDEHYDE RADIATION TOWARD COLD REGIONS OF THE GALACTIC PLANE. Gordon, M. A.; Roberts, M. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 170: No. 2, 277-9(1 Dec 1971).

A search for H_2CO along the galactic equator in directions free of discrete continuum sources failed to detect the 6-cm line in either absorption or emission. By using observations of Cas A and regions near it, it is suggested that the excitation temperature of H_2CO in these directions lies between 1.3 and 4.3°K. (auth)

5096 ACCURATE POSITION MEASUREMENTS IN THE 1720-MHz LINE OF OH. Hardebeck, Ellen G. (California Inst. of Tech., Pasadena). Astrophys. J.; 170: No. 2, 281-8 (1 Dec 1971).

Positions accurate to ±10″ were measured with the Owens Valley interferometer for seven sources in the 1720-MHz line of OH. These included three Class I sources (W3, W49, and W51) and four Class IIa sources (W28 A_1, W44, OH 1959 + 33 [ON-3], and G111.5 + 0.8). OH 1959 + 33 was found to lie close to component C of the complex radio source near NGC 6857, instead of near component A (the unusual nebula K3-50). The satellite-line position coincided with a main line position for the Class I sources. (auth)

5097 SMALL-SCALE STRUCTURE OF RADIO GALAXIES AND QUASI-STELLAR SOURCES AT 3.8 CENTIMETERS. Cohen, M. H. (California Inst. of Tech., Pasadena); Cannon, W.; Purcell, G. H.; (and others). Astrophys. J.; 170: No. 2, 207-17 (1 Dec 1971).

Fringes were observed from 31 compact radio sources, including eight known or suspected galaxies and 20 known or suspected galaxies and 20 known or suspected QSSs, by using the Goldstack interferometer at $\lambda = 3.8$ cm ($d/\lambda = 10^6$). Fringe visibility curves were obtained for nine sources showing structure on a scale of 10^{-3} sec of arc, and simple models were fitted to the data. Results for 3C 273 and 3C 279 were compared with data taken by Knight et al. at an earlier epoch. The apparent changes in brightness distribution of 3C 273 and 3C 279 were difficult to explain. (auth)

5098 SEARCH FOR REDSHIFTED NEUTRAL HYDROGEN IN 3C 48 AND OTHER COMPACT OBJECTS. Seielstad, G. A. (Chalmers Univ. of Tech., Goteborg. California Inst. of Tech., Pasadena); Hoeglund, Bertil; Kollberg, Erik. Astrophys. J.; 170: No. 2, 219-22(1 Dec 1971).

Upper limits to the possible redshifted H I absorption or emission in 3C 48, PKS 1217 + 02, PKS 1229 − 02, 3C 277.1, and 3C 171 are reported. (auth)

5099 QUASAR EVOLUTION. Cavaliere, A. (American Science and Engineering, Cambridge, Mass.); Morrison, P.; Wood, K. Astrophys. J.; 170: No. 2, 223-31(1 Dec 1971).

The consequences for quasar statistics of a class of models describing the evolution of individual strong sources were examined. The continuity equation for the change of density and luminosity with cosmological epoch determines the population, once a model for the evolution of an individual object is chosen. A dynamical model of spinning objects seems to agree satisfactorily with the present observational sample, both in density and in luminosity function; such a model requires that an individual object strongly brightens as time goes on. A genetic relationship between quasars and radio galaxies which qualitatively fits the observations is suggested by the model. (auth)

5100 APPARENT ASSOCIATIONS BETWEEN BRIGHT GALAXIES AND QUASI-STELLAR OBJECTS. Burbidge, E. M.; Burbidge, G. R.; Solomon, P. M.; Strittmatter, P. A. (Univ. of California, San Diego). Astrophys. J.; 170: No. 2, 233-40 (1 Dec 1971).

A comparison of the spatial distribution of the 47 identified QSOs in the 3C and 3CR catalogs with the small-redshift galaxies contained in the Reference Catalog of Bright Galaxies shows that four QSOs with redshifts in the range 0.5 to 1.4 are much closer to bright galaxies than would be expected if the 47 QSOs were distributed randomly. An extensive analysis of the distributions shows that the probability that this is a chance occurrence is less than 5×10^{-3}. It is also shown that the radio-quiet QSO PHL 1226 with a redshift of 0.4 lies very close to the comparatively nearby galaxy IC 1746 to which it appears to have a physical connection. (auth)

5101 SPECTRUM OF RADIATION SCATTERED BY RELATIVISTIC ELECTRONS. Kegel, Wilhelm H. (Univ., Heidelberg). Astron. Astrophys.; 15: No. 2, 306-10(Dec 1971).

The spectral distribution of radiation arising from nonlinear Thomson scattering of a strong electromagnetic wave by an ensemble of ultrarelativistic electrons is discussed. Of particular importance is the fact that the energy emitted by an individual particle during a time interval T is received by the observer during an interval $T' = T(c - v_D \cos\chi)/c$, v_D being the drift velocity of the considered electron and χ the angle between v_D and the direction of observation. The derived spectrum is compared with the spectrum which is emitted by an ensemble of particles with the same energy distribution in the case of synchrotron radiation, because of the similarity of the two radiation mechanisms. Two different cases are considered: a) The radiation zone is infinite. In this case the observed spectrum is flatter than in the case of synchrotron radiation. b) The radiation zone is finite and the scattering particles are entering and leaving the interaction region. If one considers the electrons of a given energy that have contributed to the radiation observed at a time t, it turns out that at a given time these particles are contained in a volume that is essentially smaller than the radiation zone. This is due to the fact that the radiation was emitted at different times. A consequence is, that under stationary conditions the observed spectrum is identical, within some crude approximation, with that occurring in the case of emission of synchrotron radiation. (auth)

Solar Phenomena

Refer also to abstracts 5223, 5271, and 5342.

5102 (N-71-34956) NOTE ON THE CHARACTERISTICS OF SUNSPOT GROUPS WHICH PRODUCE SOLAR PROTON FLARES. Sakurai, Kunitomo (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jul 1971. 12p. (NASA-TM-X-65637). NTIS.

The association of solar proton flares with sunspot groups that show an unusual distribution of magnetic polarities is discussed. It is noted that the gradient of the magnetic field is very large before the onset of these flares and that the importance of polar cap absorptions, which is proportional to the integral flux of solar cosmic rays, tends to increase as the gradient of the magnetic field becomes greater. It is shown that the formation of such gradients is associated with the rotating motion of sunspot groups and that the sunspot groups which show a reversed polarity distribution are very effective for the production of solar proton flares. (auth) (STAR)

5103 MORE SOLAR MODELS AND NEUTRINO FLUXES. Abraham, Zulema; Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge,). Astrophys. J.; 170: No. 1, 157-63(15 Nov 1971).

Neutrino fluxes from a sequence of solar models are presented that differ from one another in regard to opacity, equation of state, and nuclear cross-section factors. Using current estimates of the relevant input parameters, capture rates are obtained that range between 3 and 10 times the most recent result of the Davis ^{37}Cl neutrino-capture experiment. The contribution to a theoretical capture rate due to neutrinos from all reactions other than ^{8}B decay ranges from 0.5 to 1.5 times the latest observational result. Comparison with results of other solar model calculations indicates reasonable agreement when results are normalized to the same input parameters. (auth)

5104 BEAM-FOIL LIFETIMES IN NEUTRAL CHROMIUM. Cocke, C. L.; Curnutte, B.; Brand, J. H. (Kansas State Univ., Manhattan). Astron. Astrophys.; 15: No. 2, 299-303(Dec 1971).

Lifetimes of several excited states in neutral chromium were measured using the beam-foil method. Beams of chromium from 50 to 100 keV were excited in passage through thin carbon foils, and the resulting downstream decay of the ensuing radiation was used to determine the lifetimes of the emitting states. The total decay rates were smaller than those obtained by summing the partial rates given by Corliss and Bozman (1962) by an average factor of 4.9, and indicated that the solar chromium abundance derived using the CB oscillator strengths is too low by approximately this factor. (auth)

5105 MODEL OF OSCILLATORY HYDROMAGNETIC DYNAMO. I. Getling, A. V.; Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 176-81(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 211-18(1971).

The possible generation of a sign-variable large-scale solar magnetic field by convective currents in the outer shell of the sun is examined. A model of a Bénard type convective cell with a Coriolis disturbance of the velocity field, i.e., a toroidal eddy with an azimuthal velocity component, is constructed. It is assumed that eddies of this kind, when they appear in a conducting medium, interact with the magnetic field and reinforce it over a time interval that is small compared with the time of ohmic dissipation. The reinforced field rotates about the axis of the eddy at the average velocity of azimuthal flow. The equation of electromagnetic induction is solved for the case when ohmic-type diffusion of the magnetic field takes place in the outer part of an inhomogeneous rotating sphere. It is assumed that conductivity is infinite in the internal region and that the field does not penetrate there. (auth)

5106 STUDY OF SOLAR COSMIC-RAY FLARE EFFECTS. Keath, Edwin Paul. Denton, Tex.; North Texas State Univ. (1971). 158p. University Microfilms Order No. 71-25,367.

Thesis.

The purpose of this study was to determine the characteristics of the solar cosmic-ray flux. The design and construction of a cosmic-ray detector system used in this study and the analysis of the data obtained from these systems are described. The cosmic-ray detector systems were flown aboard Pioneer-8 and 9 which were launched into heliocentric orbit. The cosmic-ray detector systems were designed to provide detailed measurements of a) the temporal variations of the omnidirectional cosmic-ray flux, b) the energy spectrum of the cosmic-ray particles, and c) the directional properties (i.e., anisotropy) of the cosmic-ray flux. (TSS) (Diss. Abstr. Int., B)

5107 LINEAR INSTABILITY OF A MAGNETIC NEUTRAL LINE. Valanejad, Esmail. Princeton, N. J.; Princeton Univ. (1971). 176p. University Microfilms Order No. 71-23,395.

Thesis.

The normal-mode stability analysis of a compressible fluid with finite conductivity around a neutral line of a magnetic field is considered within the framework of the linearized hydromagnetic theory. The neutral line in the magnetic field is assumed to be due to two external conductors carrying constant currents of equal strengths in the same direction. The whole system is assumed to be confined to within a perfectly conducting rigid cylinder at $r = R_0$. It is shown that in the vicinity of the neutral line the compressible character of the fluid prevails, whereas near the fluid boundary purely electromagnetic forces arising from the motion of the conducting fluid in the magnetic field dominate. In each region the appropriate equations of the linear magnetohydrodynamics are examined and a set of differential equations for the various physical quantities of interest are derived. It is demonstrated that these equations possess only one integral that is compatible with all the physical conditions at the origin. Upon matching the interior solutions with those in the vacuum outside, an eigenvalue equation is obtained. (TSS)(Diss. Abstr. Int., B)

5108 PART I. OBSERVATIONS OF THE BRIGHTNESS AND POLARIZATION OF THE OUTER CORONA DURING THE NOVEMBER 12, 1966 TOTAL ECLIPSE OF THE SUN. PART II. THE USE OF EXTINCTION FROM HIGH-ALTITUDE BALLOONS AS A PROBE OF THE ATMOSPHERIC AEROSOLS. Pepin, Theodore John. Minneapolis; Univ. of Minnesota (1970). 100p. University Microfilms Order No. 71-18,798.

Thesis.

The thesis material consists of two separate subjects and consequently is divided into two parts. I. An experiment is described in which photographs of the solar corona were obtained from a camera flown on the NASA CV-990 at an altitude of 40,000 feet during the November 12, 1966 total eclipse of the Sun. The absolute brightness, polarization, and the direction of polarization of the solar corona between 3.5 and 13 solar radii were determined from these photographs. A significant polarized component was found in this region, the structure of which is closely correlated with features in the inner corona. Comparisons are made with the July 20, 1963 and May 30, 1965 eclipses, and evidence is given for changes in brightness of the coronal light between these eclipses. II. A simple instrument developed for measuring the intensity of the solar radiation in four spectral regions is described. Instruments of this type have been used to observe the atmospheric extinction from high-altitude balloons at sunrise since mid-1965. Data from these balloon flights are described, and the vertical profiles of the atmospheric aerosols determined from these measurements are presented. Evidence is given for a time variation of aerosols at high altitude. (Diss. Abstr. Int., B)

5109 EARLY STAGE OF THE SUN. Hayashi, C. (Kyoto Univ.). pp 586-90 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The recent theory of evolution of the proto Sun is reviewed, and a picture of the evolution of the surrounding nebula is presented, especially in relation to the growth of solid particles in the nebula. (auth)

5110 ORIGIN OF ELEMENTS IN THE SOLAR SYSTEM. Hayakawa, S.; Matsumoto, T. (Nagoya Univ., Japan). pp 591-3 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The condensation of dust grains on the solar disk, and the transport of the solar primordial elements into interplanetary space are discussed in connection with the evolution of the Sun in its early stages. (W.D.M.)

5111 OBSERVATIONS OF SOLAR BURSTS AT MICROWAVE AND EXTREME-ULTRAVIOLET WAVELENGTHS. Castelli, J. P.; Richards, D. W. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 76: No. 34, 8409-13(1 Dec 1971).

During the several months in 1967 when solar emission was measured in the band 270 to 1310 A by instrumentation aboard the Oso-3 satellite, numerous flare-associated euv bursts were observed. These provided the first euv-burst data for direct comparison with microwave radio bursts. Comparison of 44 of these events with radio bursts observed at the Sagamore Hill Radio Observatory of AFCRL has been made; excellent agreement in the start time and time of burst maximum is found in most instances. On the basis of the burst morphology it is suggested that, as with the microwave burst, different mechanisms are responsible for the impulsive first component and slow-burst decay time (second component). (auth)

5112 ENERGY CHANGES OF COSMIC RAYS IN INTERPLANETARY SPACE. Gleeson, L. J.; Ng, C. K. (Monash Univ., Clayton, Australia). J. Geophys. Res.; 76: No. 34, 8434-40 (1 Dec 1971).

Murray et al. (Phys. Rev. Lett., 26: 663(1971)) observed a feature or kink in the kinetic-energy spectra of solar cosmic rays from a solar burst that decreased from 3.4 to 2.4 MeV over a period of 3 days. It was assumed that diffusion was small and concluded that the decay-time constant of this event (210 ± 10 hours) was not in accordance with energy losses due to adiabatic deceleration. Jokipii (Phys. Rev. Lett., 26: 666(1971)) proposed Fermi acceleration processes to account for the discrepancy. Calculations based on a model for solar cosmic-ray bursts were made, and it is shown here that the observed rate cannot be interpreted immediately as the rate of loss of energy. The model used for the calculations includes the effects of anisotropic diffusion along the mean interplanetary magnetic field, of convection, and of energy loss by adiabatic deceleration. (J.C.W.)

5113 SOLAR SECTOR MAGNETISM. Wilcox, John M. (Univ. of California, Berkeley). Comments Astrophys. Space Phys.; 3: No. 5, 133-9(Sep-Oct 1971).

The fundamental features of the classical Babcock model (Astrophys. J., 133: 572(1961)) of solar magnetism are briefly reviewed. It is emphasized that it is not suggested that the classical Babcock model of solar magnetism is wrong, only that it may be incomplete. Solar sector magnetism is observed under unfavorable signal-to-noise conditions, and the analysis described is mainly to point the way to future observations and analysis. (W.D.M.)

5114 TRANSITION PROBABILITIES IN INTERMEDIATE-COUPLING AND CONFIGURATION MIXING FOR Fe XVII. Loulergue, M. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 15: No. 2, 216-20(Dec 1971).

Transition probabilities between the seven configurations $2p^6$, $2p^5\,3l$, $2s\,2p^6\,3l$ ($l = 0, 1, 2$) of Fe XVII were computed in intermediate coupling, including the full configuration mixing within a given complex as suggested by Layzer (1959). (auth)

Galaxies

Refer also to abstracts 5217, 5224, and 6051.

5115 RADIAL VELOCITIES AND LINE STRENGTHS OF EMISSION LINES ACROSS THE NUCLEAR DISK OF M31. Rubin, Vera C.; Ford, W. Kent Jr. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 170: No. 1, 25-52(15 Nov 1971).

Image-tube spectra were obtained at sixteen position angles across the nuclear bulge of M31, at a dispersion of 28 Å mm^{-1}. Emission lines of Hα, [N II] λλ6548 and 6583, [S II] λλ6717 and 6731, He I λ5876, and [O III] λ5007 were observed. From the measured line-of-sight velocities of the excited gas across the inner 400 pc, the following model was obtained: Gas is concentrated in a very thin rotating disk with rotational velocities of the gas increasing to $V = 200$ km s^{-1}; the rotation is not axially symmetric. Expansion motions as large as 100 km s^{-1} exist in position angles 68 to 118° and 248 to 278°, but less than $0.01\,\mathcal{M}_\odot$ $year^{-1}$ is leaving the R = 400 pc region. Excess positive velocities observed in one quadrant are correlated with positions of absorbing clouds near the nucleus of M31, and may indicate infalling motions of low lying clouds. Extreme density fluctuations are present; the total mass of ionized gas to R = 400 pc is probably less than $10^5\,\mathcal{M}_\odot$. Over this region the average surface brightness is $S = 0.2 \times 10^{-5}$ ergs cm^{-2} s^{-1} $sterad^{-1}$ in Hα, and twice this in [N II] λ6583. (auth)

5116 HIGH-SPEED INTERSTELLAR GAS DYNAMICS: SHOCKS MODERATED BY COSMIC RAYS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J.; 170: No. 1, 53-63(15 Nov 1971).

Cosmic rays interact with the thermal interstellar gas through a "cosmic-ray sound speed" of the order of (cosmic-ray energy density/thermal gas density)$^{\frac{1}{2}}$, typically 10 to 10^2 km s^{-1}. Gas motions faster than the thermal sound speed may be moderated by the cosmic rays. The cosmic-ray sound speed and the jump conditions across cosmic-ray-dominated shocks are derived on the assumption that the cosmic rays and the interstellar gas interact via resonant hydromagnetic waves. Cosmic-ray shocks occur where gas is driven through the cosmic rays by gravity, for instance at the "high-velcoity" clouds if these are gas falling into the Galaxy, or where cosmic rays experience a density gradient, for instance around supernovae. In all cases, the cosmic rays lose energy to the gas, affecting understanding of both the cosmic rays (is there any need to store them in a galactic "halo"?) and interstellar gas dynamics (are cosmic rays the missing source of kinetic energy for interstellar clouds?). In case the high-velocity clouds are subsonic, however, the cosmic rays may cushion their infall so that no shock occurs at all. (auth)

5117 INTERPRETATION OF THE ABSOLUTE INTENSITY OF THE DIFFUSE GALACTIC LIGHT. Mattila, K. (Univ. of Helsinki). Astron. Astrophys.; 15: No. 2, 292-8(Dec 1971).

An interpretation of the absolute intensity of the diffuse galactic light at the galactic equator is presented. The discrete cloud structure of interstellar dust is taken into account, and it is shown to have a considerable effect on the determination of the grain properties. The calculated intensity of the diffuse light is compared with the observations of Witt (1968a) in Cygnus and Taurus–Auriga. The difference in the observed intensity between these two directions can be explained as an effect of forward scattering. Quantitatively, one finds that the asymmetry factor g is greater than 0.75, and the albedo can be restricted to the range $0.3 < a < 0.7$. (auth)

5118 DISTRIBUTION OF O AND EARLY B STARS, GAS, AND COSMIC DUST ACROSS THE CARINA SPIRAL FEATURE. Miller, Ellis Wilson. Tucson, Ariz.; Univ. of Arizona (1971). 225p. University Microfilms Order No. 71-24,893.

Thesis.

Current theories of galactic spiral structure predict a stratification of gas, stars, and dust across galactic spiral arms. Such predictions can be tested by studies of the longitudinal distribution of matter in spiral arms that are observed tangentially to the line of sight. The Carina spiral feature is ideal for such a study. Published data were used to analyze the distribution of H I and H II across the Carina spiral feature. Photometric and photographic data were collected at the Cerro Tololo Interamerican Observatory and these were used to initiate a search for faint blue stars in the Carina spiral feature and for the study of the longitudinal distribution of interstellar absorption. The distribution of H I across the Carina spiral arm is shown to be very broad. At a distance of 4 kpc from the Sun, the width of the densest H I concentrations is 1000 parsecs. However, less dense H I spills out at each edge. If it is included, the width is increased by at least 500 parsecs. The ionized H II regions are shown to have a narrower longitude distribution. The outer boundary is near $l = 282°$, and the inner boundary is near $l = 292°$. At a distance of 4 kpc from the Sun the width of the H II distribution is approximately 800 parsecs. The blue star search resulted in the identification of 133 new OB stars. Most of these stars are fainter than 13th magnitude. The largest numbers of faint blue stars are found near $l = 289°$, and thus, confirm earlier studies which indicated that the stellar arm is strongly concentrated between $l = 285°$ and 292°. The colors and magnitudes of the faint blue stars were used to study the distribution of interstellar absorption across the Carina spiral feature. Total absorption values as large as 3 to 4 magnitudes were found. However, it was not possible to determine precisely the distances over which these values occur. A model of the Carina spiral feature is presented that will serve as a basis for comparison with future observational and theoretical studies of spiral structure in the Vela–Carina–Centaurus section of the Milky Way. (Diss. Abstr. Int., B)

5119 OBSERVATIONS OF INTERSTELLAR Ca I LINES. Hobbs, L. M. (Univ. of Chicago). Astrophys. J.; 170: No. 2, L85-8(1 Dec 1971).

Interferometric, photoelectric scans of the interstellar Ca I line at λ4226 are reported for four stars having strong interstellar Ca II K-lines. The Ca I line is detected in three, and possibly all four, cases, of which one was known previously. Negative Ca I results are also obtained for six stars with weaker K-lines. The significance of the resulting electron densities deduced from the Ca I and Ca II lines is discussed. (auth)

5120 RECTANGULAR COORDINATES OF RICH CLUSTERS OF GALAXIES ON THE PALOMAR SKY SURVEY CHARTS. Sastry, Gummuluru N.; Rood, Herbert J. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; Suppl. Ser.; 23: No. 201, 371-419 Nov 1971).

Rectangular coordinates of the 2712 rich clusters listed in Abell's catalog were calculated that allow quick identifications to be made on the charts of the National Geographic–Palomar Observatory Sky Survey. Right ascensions and declinations are given for epoch 1950 to facilitate the identification of Abell clusters with radio sources and clusters listed in other references. (auth)

5121 REDSHIFTS AND ABSOLUTE SPECTRAL ENERGY DISTRIBUTIONS OF GALAXIES IN DISTANT CLUSTERS. Oke, J. B. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 170: No. 2, 193-8 (1 Dec 1971).

Absolute spectral energy distributions were obtained for galaxies in three distant clusters. Comparison with the energy distribution of the integrated light from nearby giant elliptical galaxies yielded redshifts and information concerning evolutionary effects. The Hydra cluster (0855 + 0321) gave the known result that $z = 0.20$. A galaxy in the cluster (0024 + 1654) yielded $z = 0.38$, and the absorption spectrum of 3C 295 gave $z = 0.46$ which agrees with Minkowski's redshift. All had errors of ±0.01. The energy distributions for these galaxies showed no evidence within the accuracy of the data for any evolution during the last 3 to 6 billion years. There is a suggestion that below 2800 Å at the spectral energy distribution for 3C 295 may flatten in a fashion analogous to that observed in nearby galaxies with OAO-2. (auth)

5122 GROUPS OF GALAXIES: HIDDEN MASS OR QUICK DISINTEGRATION. Field, George B.; Saslaw, William C. (Univ. of California, Berkeley). Astrophys. J.; 170: No. 2, 199-206(1 Dec 1971).

In small groups of galaxies there are correlations between the value of the mass discrepancy (defined as the ratio of virial mass to luminous mass) and other characteristics of the group, including the average morphological type of galaxies in the group, and the time for galaxies to cross the group. The significance of these correlations for possible explanations of the mass discrepancy is discussed. It is concluded that likely explanations include binding by large amounts of ionized gas, or quick disintegration, perhaps because of gravitational mass loss or ejection of intergalactic gas. (auth)

5123 GALACTIC WINDS. Mathews, William G. (Univ. of California, Santa Cruz); Baker, James C. Astrophys. J.; 170: No. 2, 241-59(1 Dec 1971).

Gas ejected from stars in elliptical galaxies is heated by supernova explosions and produces outward-flowing galactic winds. Except possibly for the dust component, steady-state galactic winds are impossible to observe. However, some galactic winds have thermally unsteady cores which can be observed in optical emission lines. If the gas which is thermally unsteady remains ionized as it goes into free fall at the galactic center, objects more massive than stars tend to form. It is likely that nonthermal radio emission and optical line emission can occur only in those ellipticals with thermally unsteady galactic winds. (auth)

5124 CHARACTERISTICS OF DISK AND HALO POPULATIONS DERIVED FROM PHOTOGRAPHIC PHOTOMETRY. Weistrop, Donna Etta. Pasadena, Calif.; California Inst. of Tech. (1971). 180p. University Microfilms Order No. 71-27,113.

Thesis.

The nature of faint stars at high galactic latitudes was investigated through U, B, V photometry of several thousand stars between $V = 12$ and 18 near the North Galactic Pole. Magnitudes were determined from iris-photometer measurements of plates taken with the 48-inch Schmidt telescope. Calibration was provided by a photoelectric sequence in the field. Several models for the luminosity function and density distribution of Population II field stars were assumed. Assuming also that all stars bluer than $(B-V)_0 = .5$ and fainter than $V = 17$ are members of Population II, an upper limit of 7×10^{-5} solar masses per pc^3 was calculated for the local Population II density, a result significantly lower than local densities computed from the number of nearby stars suspected of halo membership. Some of the discrepancy may be due to the method used. Having estimated the contributions to the star counts due to Population II stars and disk giants and subgiants, the remaining stars were assumed to constitute a pure disk dwarf population. Density distributions for stars in successive $(B-V)_0$ intervals were calculated and combined to form a composite disk density distribution. The agreement with Oort's K giant distribution is satisfactory. There was some indication that the faintest dwarfs are concentrated in a narrow layer in the plane, but further investigation is required. Determination of the luminosity function for the reddest disk dwarfs indicated these stars are five to ten times as numerous as was previously thought, thus accounting for a significant fraction of the missing mass in the solar neighborhood. Luminosity functions extrapolated to account for all the missing mass are indicated. (Diss. Abstr. Int., B)

Cosmology

Refer also to abstracts 5878 and 5883.

5125 EXPANSION ANISOTROPY AND SPECTRUM OF COSMIC-BACKGROUND RADIATION. Rasband, S. N. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 170: No. 1, 1-15 (15 Nov 1971).

The spectrum of primeval-fireball radiation is considered in a homogeneous axisymmetric anisotropic world model which includes the effects of electron neutrinos on expansion dynamics. Characteristic deviations from a thermal spectrum are found, but current measurements of the background intensity do not further re-

strict expansion anisotropy beyond the limits set by isotropy measurements of the fireball. These limits require the fractional deviation from unity for the ratio of current-day expansion rates in orthogonal directions to be less than $\sim 5.0 \times 10^{-7}$ or in a narrow range around 3.8×10^{-6}. Corresponding limits on expansion anisotropy in the early Universe ($T \simeq 3 \times 10^{10}$°K) are also obtained. Anisotropy in the fireball radiation is found to increase with frequency in a way nearly independent of the amount of expansion anisotropy. Inclusion of a possible hot intergalactic plasma alters this dependence and increases the permissible limits on expansion anisotropy without violating the observational limits on the spectrum. (auth)

5126 MATTER–ANTIMATTER HYDRODYNAMICS: THE COALESCENCE EFFECT. Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Astron. Astrophys.; 15: No. 2, 275-84(Dec 1971).

The hydrodynamical motion of a system consisting of matter and antimatter embedded in thermal radiation was investigated. These motions are generated by the pressure which is due to the annihilation products (Alfvén and Klein Leidenfrost mechanism) and by thermal convection which transports the energy released by annihilation. It is shown that the Leidenfrost effect is compensated by the gradients of the radiative pressure, so that thermal convection is dominant and its velocity can be simply written. These results are obtained under the physical conditions which are assumed to take place during the radiative period in a matter-antimatter Universe. The coalescence of matter systems into regions having a size of the order of the mean free path for high-energy photons is established for simple cases. (auth)

5127 THEORETICAL FRAMEWORKS FOR TESTING RELATIVISTIC GRAVITY; THE PARAMETRIZED POST-NEWTONIAN FORMALISM. Will, Clifford Martin. Pasadena, Calif.; California Inst. of Tech. (1971). 120p. University Microfilms Order No. 71-27,114.

Thesis.

Increasing sophistication and precision of experimental tests of relativistic gravitation theories has led to the need for a detailed theoretical framework for analyzing and interpreting these experiments. Such a framework is the Parametrized Post-Newtonian (PPN) formalism, which treats the post-Newtonian limit of arbitrary metric theories of gravity in terms of nine metric parameters, whose values vary from theory to theory. The theoretical and experimental foundations of the PPN formalism are laid out and discussed, and the detailed definitions and equations for the formalism are given. It is shown that some metric theories of gravity predict that a massive, self-gravitating body's passive gravitational mass should not be equal to its inertial mass, but should be an anisotropic tensor which depends on the body's self-gravitational energy (violation of the "principle of equivalence"). Two theorems are presented that probe the theoretical structure of the PPN formalism. They state that (i) a metric theory of gravity possesses post-Newtonian integral conservation laws if and only if its nine PPN parameters have values which satisfy a set of seven constraint equations, and (ii) a metric theory of gravity is invariant under asymptotic Lorentz transformations if and only if its PPN parameters satisfy a set of three constraint equations. Some theories of gravity (including Whitehead's theory and theories which violate one of the "Lorentz-invariance" parameter constraints) are shown to predict an anisotropy in the Newtonian gravitational constant. Gravimeter data on the tides of the solid Earth are used to put an upper limit on the magnitude of the predicted anisotropy, and thence to rule out such theories. (Diss. Abstr. Int., B)

5128 DISSIPATION OF PRIMORDIAL TURBULENCE AND THERMAL HISTORY OF THE UNIVERSE. Matsuda, Takuya; Sato, Humitaka; Takeda, Hidenori (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 416-32(Aug 1971).

The assumption that in the early stage of the Universe there existed turbulence of photons and plasma dragged by them can plausibly explain the formation of galaxies. Using simple expressions to represent the decay law of the primordial turbulence, the thermal history of gas at the pre-galactic stage is followed and the residual ionization degree of hydrogen is computed. It is found that maximum temperatures attainable are about $10^{4.6}$K for a wide range of heating parameters. This is because a kind of thermostat that keeps gas temperature below $10^{4.6}$°K operates: the increase of temperature above $10^{4.6}$°K is prevented by the increase of the ionization degree and the resultant increase of cooling rate. Therefore, it can be concluded that galaxies cannot be formed through the thermal instability due to heating by the primordial turbulence. (auth)

5129 REMOVAL OF INITIAL SINGULARITY IN A BIG-BANG UNIVERSE IN TERMS OF A RENORMALIZED THEORY OF GRAVITATION. I. EXAMINATION OF THE PRESENT STATUS AND A NEW APPROACH. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 433-8 (Aug 1971).

The present status of the problem of initial singularity, characteristic of any model Universe compatible with the cosmological interpretation of the 3°K blackbody radiation, is examined from the standpoints of both classical and quantum cosmologies. One of the most striking results in this problem is Misner's result that quantum effects do not significantly modify the nature of initial singularity in relativistic cosmology, while there remains as yet some doubt as regards its universal validity. A new approach is, therefore, proposed, the essence of which lies in modifying the Einstein field equations in a physically reasonable manner on the basis of a renormalized theory of gravitation due to Utiyama and DeWitt. (auth)

5130 SEARCH FOR SPECTRAL FEATURES IN SUBMILLIMETER BACKGROUND RADIATION. Mather, John C.; Werner, Michael W.; Richards, P. L. (Univ. of California, Berkeley). Astrophys. J.; 170: No. 2, L59-65(1 Dec 1971).

Mountaintop observations were made at 1% spectral resolution of atmospheric and sky emission in the frequency region $\nu = 6 - 14$ cm^{-1}. No emission features were found which can be related to the diffuse, isotropic flux $F_0 = 1.3 \times 10^{-9}$ W cm^{-2} sterad^{-1} reported from rocket and balloon experiments. One can thus set a lower limit to the spectral width of any feature responsible for F_0. This limit varies from 0.25 cm^{-1} (for $\nu = 13.5$ cm^{-1}) to 0.5 cm^{-1} (for $\nu <$ 10 cm^{-1}), and is equal to 0.4 cm^{-1} over most of the 10 to 12 cm^{-1} region. Since the possibility that the radiation lies in a single narrow line such as might arise from a maser process in the upper atmosphere is excluded, the observations seem to require an extraterrestrial origin for F_0. (auth)

5131 ASTROPHYSICAL IMPORTANCE OF HEAVY LEPTONS. de Graaf, T. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Lett. Nuovo Cim.; 2: No. 19, 979-84(6 Nov 1971).

Theories have been put forward in which the existence of more than two leptons is assumed and recently some attention has been given to possible experiments related to the influence of these new particles. The consequences that the existence of one or more other leptons might have for astrophysics are pointed out, in particular, for stellar evolution and cosmology. (W.D.M.)

5132 HADRON BARRIER IN COSMOLOGY AND GRAVITATIONAL COLLAPSE. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Frautschi, Steven. Contract AT(11-1)-68. Astrophys. J.; 170: No. 2, L81-4(1 Dec 1971).

It is shown that the early stages of a big-bang cosmology are hadron-dominated if the density of hadron states per unit mass interval, $\rho(m)$, increases at least as fast as m^{-1} and if the initial gravitational anisotropy is not large. It is further shown that if these conditions are satisfied, then quantum effects must modify the classical equations of general relativity at times $t \sim 10^{-23}$ s before the attainment of the singularities predicted in classical relativistic cosmologies and stellar collapse (i.e., before the well-known modifications due to quantum fluctuations of the metric at times $\sim 10^{-43}$ s). (auth)

5133 SEARCH FOR HYPERFINE LINE FROM SINGLY IONIZED ^{3}He IN GALACTIC H II REGIONS. Predmore, Clayton Read. Houston, Tex.; Rice Univ. (1971). 147p. University Microfilms Order No. 71-26,342.

Thesis.

An attempt to measure the cosmic abundance of the rare ^{3}He isotope through detection of hyperfine radiation at 8666 MHz from singly ionized ^{3}He in galactic diffuse nebulae is described. The 140-foot telescope at the National Radio Astronomy Observatory was used in the search, in conjunction with a cryogenic parametric amplifier receiver specially designed and constructed at Rice University. A new, thorough data-reduction technique was developed in the course of the observational analysis. From effective observational procedures and a thorough data analysis, a stringent new upper limit of 4×10^{-5} for the ^{3}He-to-H abundance ratio was established. This limit was determined with a limiting signal to noise ratio five times lower than any previous searches for He. The implication of this abundance was quantitatively analyzed in the light of existing cosmological theories and models of stellar and galactic evolution. Also, in the course of the investigation, a very faint hydrogen recombination was detected with a signal-to-noise ratio of 20. This line results from the high quantum level transitions between states of principal quantum number 178 and 171. This marks the first detection of such a transition with a change in principal quantum number greater than five, and serves to illustrate the high quality of the observational data. (Diss. Abstr. Int., B)

Planetary Phenomena

Refer also to abstract 5252.

5134 $(^{78}Kr/^{83}Kr)_{sp} - (^{131}Xe/^{126}Xe)_{sp}$ CORRELATION IN APOLLO 12 ROCKS. Schwaller, H.; Eberhardt, P.; Geiss, J.; Graf, H.; Groegler, N. (Univ., Bern). Earth Planet. Sci. Lett.; 12: No. 2, 167-9(Oct 1971).

The Apollo 12 rocks show, similar to the Apollo 11 rocks, a good correlation between the $^{78}Kr/^{83}Kr$ and the $^{131}Xe/^{126}Xe$ ratios of the spallation component. The correlation line is distinctly different for Apollo 11 and 12 rocks, reflecting the difference in the Sr/Zr abundance ratio. Correlation lines as functions of the Sr/Zr ratios are derived. A resonance integral of the order of 150 barns would be required to explain the excess $^{131}Xe_{sp}$ by the capture of epithermal neutrons in ^{130}Ba. (auth)

5135 OXIDATION STATE OF IRON IN PLAGIOCLASE FROM LUNAR BASALTS. Hafner, S. S.; Virgo, D.; Warburton, D. (Univ. of Chicago). Earth Planet. Sci. Lett.; 12: No. 2, 159-66(Oct 1971).

Mossbauer spectra of ^{57}Fe at 77 and 295°K in the plagioclase from basalts 10044 and 12021 show that iron is in the high-spin ferrous state and located at least two distinct positions with different coordination numbers. Some excess resonant absorption is probably due to Fe^{3+} although the Fe^{3+} doublet could not be positively resolved. The ratio $Fe^{3+}/(Fe^{2+} + Fe^{3+})$ is estimated to be between 0.02 and 0.1. (auth)

5136 SEARCH FOR EXOELECTRONS IN APOLLO 12 MATERIALS. Gammage, Richard B.; Becker, Klaus (Oak Ridge National Lab., Tenn.). Earth Planet. Sci. Lett.; 12: No. 2, 155-8(Oct 1971).

The search for exoelectron emission from Apollo 12 materials usually produced negative results, suggesting that the concentration of naturally occurring traps is very low. Weak exoelectron activity was found scattered inhomogeneously within a pigeonite basalt rock and in a deep core tube sample. Its erratic appearance and intensity makes any interpretation of radiation history most difficult and is attributed to the activity being carried by only a few scattered crystals. The thermally stimulated emission of exoelectrons is judged an unsuitable technique for tracing the radiation histories of these samples. (auth)

5137 URANIUM-BEARING MINERALS OF LUNAR ROCK 12013. Haines, E. L.; Albee, A. L.; Chodos, A. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 12: No. 2, 145-54(Oct 1971).

The U distribution in rock 12013 was studied by fission-track and elemental mapping techniques. Major U-bearing phases are whitlockite, apatite, zircon, and phase β, which is a Zr–Ti mineral rich in Fe, Nb, Y, REE and containing up to 3.6% UO_2, 4.7% ThO_2, and 4.2% PbO. Calculated microprobe ages for phase β average 4.0 AE and are in reasonable agreement with Rb–Sr and K–Ar ages. Phase β plays a significant role in the U–Th–Pb systematics of rock 12013 and may play a similar role in the model ages of lunar soil. (auth)

5138 ANALYTICAL STUDIES OF SELECTED JOVIAN DECAMETRIC PHENOMENA. Olsson, Carl Niels. Gainesville, Fla.; Univ. of Florida (1970). 133p. University Microfilms Order No. 71-24,963.

Thesis.

The Jovian 18- and 22.2-MHz radiation data, collected at the University of Florida Radio Observatory and the Maipu Radio-Astronomical Observatory, on high-speed recorders, were separated into L bursts and S bursts. These two groups of data were then independently studied to determine their distributions in longitude and also examine to what extent the bursts were influenced by the satellite Io. The noise storms from sources B and C contained a greater percentage of S bursts than those from source A. The L bursts from source A seemed to be insensitive to the position of Io, whereas the source-A S bursts showed an Io effect. Both types of bursts from sources B and C were influenced by Io. All of the Florida and Maipu data at the frequencies of 15, 18, 22.2, and 27.6 MHz were investigated in an attempt to determine any possible frequency or source dependence of the sinusoidal drift of the sources. The results of this study were negative, possibly due to the difficulty in locating sources B and C at the lower frequencies and for apparitions of low activity. The 18- and 22.2-MHz radiations were analyzed in order to check the hypotheses of Duncan that (1) the radio rotation period is different from the System III (1957.0) value when it is determined by considering the commencement times of source-A storms for each apparition, and (2) that the drift is due to a variation in the duration of the storms. From this study it was concluded that this method of determining the rotation period is questionable and that the drift cannot be accounted for by a variation in the storm durations. Finally, the question of possible satellite influence on the radiation by Amalthea and by two hypothetical satellites was considered. No significant influence was detected in this study. (Diss. Abstr. Int., B)

5139 RESULTS FROM THE SOVIET LUNA 16 MISSION: ^{87}Rb–^{87}Sr AGE ESTIMATION AND K, Rb, Sr, Ba, AND RARE EARTHS CONTENTS FROM THE MARE FOECUNDITATIS SURFACE. Allegre, C. J.; Birck, J. L.; Loubet, M.; Provost, A. (Univ., Paris). Compt. Rend., Ser. D; 273: No. 9, 779-82(30 Aug 1971). (In French).

A sample of the lunar surface was taken automatically with the probe, Luna 16, in the Mare Foecunditatis. The results are presented in a graph showing the isotopic evolution of Sr and demonstrate that this surface possesses less radiogenic ^{87}Sr than any other part of the lunar surface, and that the sample lies approximately on the straight line representing an age of 4.6 million years which has been defined from measurements in other areas. Furthermore, the sample of Luna 16 is the least rich in K, Rb, and rare earths, but contains the most Sr. (France)

5140 RADIO OBSERVATIONS OF MARS AT 8.57 MILLIMETERS. Kalaghan, P. M.; Telford, L. E. (Air Force Cambridge Research Labs., Bedford, Mass.). Astrophys. J.; 170: No. 2, L77-9(1 Dec 1971).

Radio emission of Mars at 8.57 mm was observed during the planet's close approach in 1971. The ratio of the Martian brightness temperature to that of Jupiter was found to be 1.23 ± 0.03. If the brightness temperature of Jupiter is taken to be 142° ± 12°K, then the resultant brightness temperature of Mars was 175° ± 15°K. (auth)

5141 CHEMICAL LINKS BETWEEN STONY METEORITES AND THE LUNAR SURFACE. Ahrens, L. H. (Univ. of Cape Town). Comments Earth Sci., Geophys.; 2: No. 1, 22-7(Jun-Jul 1971).

Recently Taylor (1971) dealt with the tektite–moon relationship. Here, the stony meteorite–Moon relationship is considered. As an example of chemical similarity, the element chromium is considered in particular. Chromium has been determined in many strong meteorites, fines from four areas on the lunar surface, and numerous terrestrial basalts. (W.D.M.)

5142 THIN HIGHLY CONDUCTING LAYER IN THE MOON: CONSISTENT INTERPRETATION OF DAYSIDE AND NIGHTSIDE ELECTROMAGNETIC RESPONSES. Schubert, G. (Univ. of California, Los Angeles). J. Geophys. Res.; 76: No. 34, 8174-80(1 Dec 1971).

The vacuum transient response of the moon to a time-varying spatially uniform magnetic field is determined for a lunar electric-conductivity model that was based on the harmonic analysis of Apollo-12 and Explorer-35 dayside magnetometer data. The transient response of the model is found to provide a plausible explanation of the behavior of the local vertical-surface magnetic field for an Apollo-12 magnetometer darkside transient event. A model containing a conducting core and a highly conducting thin subsurface layer is presented, and its transient behavior is discussed. (auth)

5143 RATE CONSTANTS FOR THE REACTIONS OF CO_2^+ + H AND $H^+ + CO_2$. Fehsenfeld, F. C.; Ferguson, E. E. (NOAA Environmental Research Labs., Boulder, Colo.). J. Geophys. Res.; 76: No. 34, 8453-4(1 Dec 1971).

Measurements were made in a flowing afterglow system of the reactions of $CO_2^+ + H$ and $H^+ + CO_2$ for reasons of potential applicability of the study to the Mars and Venus aeronomy. The overall reaction rate constant is 6×10^{-10} cm^3 sec^{-1} at 300°K, probably reliable to within a factor of 2. The uncertainty is due to the greater difficulty in measuring H-atom concentrations and the instability of the H-atom source due to erratic fluctuations in the H-atom source derived from an H_2 discharge. Independent evidence shows that the H-atom concentration determinations were essentially correct because a number of other reactions were measured at the same time. (J.C.W.)

5144 DIFFICULTIES WITH THERMAL PROTONS IN THE VENUSIAN TOPSIDE IONOSPHERE. Banks, Peter M. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 76: No. 34, 8455-6(1 Dec 1971).

In Venusian ionosphere models the presence of light ions such as H^+ or He^+ has been assumed. It now appears that H^+ is not of significant concentration in the Venusian topside ionosphere. The presence of H^+ in the ionosphere cannot be explained by photoionization since the rate for this process is too slow. A discussion is given regarding a letter by Fehsenfeld and Ferguson concerning the rate constants for the reactions of $CO_2^+ + H$ and $H^+ + CO_2$. However, the principal reaction between CO_2^+ and H does not give H^+ and CO_2, but rather goes as $CO_2^+ + H \xrightarrow{k_2} COH^+ + O$. Emphasis has been placed on the concentration of He^+, but it might be that O^+ at a high temperature could explain the experimental data. It is concluded that thermal protons of planetary origin are rapidly destroyed in the Venusian ionosphere, and they cannot be the principal topside ions. (J.C.W.)

5145 ORTHOPYROXENE AND ORTHOPYROXENE-BEARING ROCK FRAGMENTS RICH IN K, REE, AND P IN APOLLO 14 SOIL SAMPLE 14163. Fuchs, Louis H. (Argonne National Lab., Ill.). Earth Planet. Sci. Lett.; 12: No. 2, 170-4(Oct 1971).

Orthopyroxene of various compositions are reported in the <1-mm fines in lunar soil sample 14163. The mineral occurs as individual grains and as a major and minor constituent in lithic fragments. K is not positively correlated with REE and P in the orthopyroxene-containing igneous rock fragments studied. Although an x-ray powder pattern of the rare earth element-containing calcium phosphate is that of whitlockite, it is tentatively concluded that the weak pattern observed results from an intimate admixture of a major amount of an amorphous phosphate of unknown composition with a lesser amount of crystalline whitlockite. (auth)

Atomic and Molecular Physics

Refer also to abstract 4180.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 5579, 5587, and 6043.

5146 (RISO-241) COMMENTS ON THE SCATTERING OF CHARGED PARTICLES BY SINGLE CRYSTALS. II. FAST ELECTRONS. Johnson, E.; Chadderton, L. T. (Danish Atomic Energy Commission, Risoe, Research Establishment). Feb 1971. 12p. Dep. NTIS (U. S. Sales Only).

The scattering of fast electrons (1 MeV and less) is shown to be explicable only in terms of extended waves and quantal interference processes. Supporting evidence from electron microscope work is cited. (auth)

5147 ENERGETIC NEUTRALS IN ION-BOMBARDMENT EXPERIMENTS WITH LOW-ENERGY NOBLE-GAS IONS. Oechsner, H.; Gesang, W. R. (Univ., Wuerzburg, Ger.). Phys. Lett.; 37A: No. 3, 235-6(22 Nov 1971).

For normal and oblique incidence of noble gas ions on polycrystalline Mo surfaces, the fraction of the primary energy carried back from the target by energetic neutrals has been determined at bombarding energies of 300 to 900 eV. (auth)

5148 RELATIVISTIC BEAM EQUILIBRIA. Benford, Gregory; Book, David L. (Univ. of California, Livermore). Advan. Plasma Phys.; 4: 125-71(1971).

A theoretical review of the kinetics of high-current relativistic electron beams is given. Axial-current models and azimuthal-current models are described in particular. 41 references. (M.O.W.)

5149 STUDY OF INTENSITIES OF AUGER LINES EXCITED BY ELECTRON BOMBARDMENT AND Al K α X-RAY IRRADIATION. Pessa, M. (Univ. of Oulu, Finland). J. Appl. Phys.; 42: No. 13, 5831-6(Dec 1971).

Intensities of Auger lines excited by 5-keV electron bombardment and 1.5-keV Kα x irradiation are compared. The most intensive lines related to LMM or MNN Auger transitions in Fe, Cu, Ag, and Sn metal films are measured with a cylindrical spectrometer with an energy resolution of 0.06%. The effective Auger current is found to depend strongly on the excitation method in the energy region, 0.3 to 1 keV, studied. The factor τ_i^{ph}/σ_i (the ratio of the photoelectric absorption coefficient and the ionization-subshell cross section for an electron impact corrected with respect to the electron backscattering) is found to be proportional to the relative line intensities that can be expected in an Auger spectrum when x irradiation or electron bombardment is considered as an excitation method of the specimen. (auth)

5150 XENON M X-RAY SPECTRA FROM ION-ATOM COLLISIONS. Fortner, R. J.; Der, R. C.; Kavanagh, T. M. (Univ. of California, Livermore). Phys. Lett.; 37A: No. 3, 259-60(22 Nov 1971).

Soft x-ray spectra from collisions involving 180-keV Xe^{++} ions and Cr, Mn, Fe, Co, Ni, Cu, and Xe targets are presented. Promotion of electrons into the normally vacant 4f level of Xe is observed, and this promotion is found to be a strong function of the Z of the target. (auth)

5151 STUDY OF ATOM COLLISION PROCESSES BY SENSITIZED FLUORESCENCE METHOD. Tudorache, St. (Institutul Politehnic, Bucharest). Stud. Cercet. Fiz.; 23: No. 2, 207-26 (1971). (In Rumanian).

Topics discussed theoretically include: collision of alkaline excited atoms with unexcited alkaline atoms; collision of alkaline excited atoms with noble gas atoms in the ground state; and collision of alkaline excited atoms with molecules in the ground-state. 38 references. (auth)

5152 SECONDARY ELECTRON EMISSION FROM THIN METAL FOILS PRODUCED BY 30-MeV ELECTRONS. Naber, J. A.; Berger, R. A. (Gulf General Atomic Inc., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 260-3(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Secondary electron emission from thin metal foils is measured for incident 30-MeV electrons as a function of foil thickness from 0.02 to 3 g/cm^2. The emission is divided into high-energy and low-energy components with the magnitude of the high-energy emission ranging from 3 to 12% and the low-energy emission from 3 to 6%. These experimental data can be described satisfactorily by two theoretical models. (auth)

5153 SECONDARY ION YIELDS IN A SPUTTERING MASS SPECTROMETER. Doi, H.; Tamura, H., Omura, I.; Kondo, T.; Taya, S. (Hitachi Ltd., Tokyo). pp 1089-93 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Secondary ion yields from bombardment of B, Al, Mg, Si, Mn, Cu, Ge, Cd, Sn, and Au by 10-keV Ar^+ ions are reported briefly. Yields of Si^+ from Si wafers bombarded by Ar^+ ions of energies between 2 and 9.8 keV were measured as a function of time. Results indicate that early maxima and minima in the yields are due to adsorbed gases; after the adsorbed gases are sputtered out, the yields become constant. Intensities of various secondary ions from a 50% Nb-50% Zr alloy bombarded by 10-keV Ar^+ ions were measured as a function of time. Results indicate that ion etching can be used for analysis of such solids. (A.G.W.)

5154 MASS-SPECTROMETRIC STUDIES OF EFFECTS CONNECTED WITH MeV ION CHANNELING IN METAL MONOCRYSTALS. Kaminsky, M. (Argonne National Lab., Ill.). pp 1167-72 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The dependence of energy loss, secondary-electron emission, and total sputtering yield on crystallographic orientation of monocrystalline Cu and Ag targets bombarded by protons in the energy range 0.1 to 4.0 MeV was measured. The energy-loss rate of channeled particles was found to decrease in the order (111) > (100) > (110), which is the same order observed for the yield values. Charge-transfer processes were studied by bombarding Cu(100) foils and polycrystalline Cu foils by $^3He^+$ ions in the energy range 0.6 to 2.0 MeV and measuring the ratio of $^3He^{2+}$ to $^3He^+$ ions in the emergent beam. (A.G.W.)

5155 ENERGETIC AND ANGULAR DISTRIBUTION OF ELECTRONS REFLECTED INELASTICALLY BY THE BERYLLIUM LAYER. Kryn'ko, Yu. N.; Mel'nik, P. V.; Nakhodkin, N. G.; Chernii, B. S. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 808-11(May 1971). (In Russian).

Angular and energy distribution of electrons reflected inelastically from a massive layer of Be was studied with an incident dip of the primary beam with an energy of 0.4 to 15 keV and three emission angles of inelastically reflected electrons. The angular distribution of inelastically reflected electrons is obtained to be almost isotropic for small energies, and at large ones is elongated in the direction of specular reflection. Basic contributions to the coefficient of inelastically reflected electrons are made by electrons emitted in the direction of specular reflection and, that have only small energy losses. (auth)

5156 EXPERIMENTAL STUDIES OF ^{235}U FISSION-PRODUCT BACKSCATTERING FROM GOLD SURFACES. Albrecht, J.; Ewald, H. (Physikalisches Institut, Giessen, Ger.). Z. Naturforsch.; 26a: No. 8, 1296-1302(Aug 1971). (In German).

^{235}U fission products of known mass number (=135) and energy (=74.35 MeV) are scattered from polycrystalline gold layers of about 1000-Å and 0.4-mm thickness at different angles of incidence (5, 10, 15, and 20° towards the surface). The reflected particles are traced by glass plates and Si surface-barrier detectors. From the numbers, positions, and diameters of the etched traces in the glass, the percentages of the backscattering, angular distributions, and energies of the reflected particles are obtained. (auth)

5157 MONTE-CARLO-CALCULATIONS OF THE BACKSCATTERING OF HIGH-ENERGY HEAVY IONS FROM METAL SURFACES. Guettner, Klaus (Physikalisches Institut, Giessen,

Ger.). Z. Naturforsch.; 26a: No. 8, 1290-6(Aug 1971). (In German).

A Monte Carlo method is applied to describe the backscattering of high-energy heavy ions from metal surfaces, taking into account the energy losses. The calculations yield the angular and energy distributions of the reflected particles together with the percentage distributions of the complete particle histories. Furthermore, it is possible to get information concerning penetration depths and the number of collisions during the interaction of these particles with the metal foils. The calculated distributions are in good agreement with known experiments. (auth)

5158 PULSED SOURCE OF FAST HYDROGEN ATOMS. Barr, W. L. (Univ. of California, Livermore). J. Appl. Phys.; 42: No. 13, 5411-17(Dec 1971).

A large pulse of energetic H atoms was produced by charge-exchange neutralization of the plasma from a washer-stack plasma gun. The neutral atoms had a broad energy spectrum peaked at about 630 eV. Limiting effects apparently due to the buildup of cold plasma were observed in the pulsed gas neutralizer. No such limiting was observed when a honeycomb collimator was used to produce the gas for charge exchange. Within a half-angle of 0.65°, 7×10^{13} H atoms per pulse were detected. A diagnostic technique using a pulse of fast neutrals is suggested, and ways to increase the mean energy and the total output are discussed. (auth)

Atomic and Molecular Properties

Refer also to abstracts 4765, 4766, 5080, 5412, 5482, 5664, and 5858.

5159 (BNL-tr-426) EFFECT OF THE CHEMICAL STATE OF AN ATOM ON THE PROBABILITY OF INTERNAL CONVERSION OF γ-RADIATION. Anderson, E. M.; Khanonkind, M. A. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from 21st Annual Meeting on Nuclear Spectroscopy and Structure of the Atomic Nucleus, January 27–February 4, 1971, Moscow. 4p. (CONF-710114-1). Dep. NTIS.

It was established (Izv. Akad. Nauk SSR, Fiz. Ser., 34: 851(1970) that the internal conversion coefficient for the outer subshell of an ionized atom changes in proportion to the change in density of the electrons near the nucleus, $\Delta|\psi_{nl}(0)|^2/|\psi_{nl}(0)|^2$. This information was used in calculating the internal conversion coefficients for the O_1 valence subshell of an ^{119}Sn atom in different chemical compounds. In this paper $\Delta|\psi_{5s}(0)|^2/|\psi_{5s}(0)|^2$ is determined in the basic perturbation theory

$$\frac{\Delta|\psi_{5s}(0)|^2}{|\psi_{5s}(0)|^2} = -\frac{q(5s)}{N(5s)} + \left(1 - \frac{q(5s)}{N(5s)}\right) \times \Sigma_k\, q(n_k l_k)\delta_{5s}(n_k l_k),$$

where $q(n_k l_k)$ is the number of removed valence electrons, N(5s) is the number of 5s electrons in the neutral atom, and $\delta_{5s}(n_k l_k)$ characterizes the density change of a single 5s electron near the nucleus due to the change in the field of the atom after removal of the $n_k l_k$ electric. (auth)

5160 (LA-4501) PRESENT STATUS OF THE ANALYSES OF THE FIRST AND SECOND SPECTRA OF URANIUM (U I AND U II) AS DERIVED FROM MEASUREMENTS OF OPTICAL SPECTRA. Steinhaus, David W.; Radziemski, Leon J. Jr.; Cowan, Robert D.; Blaise, Jean; Guelachvili, Guy; Osman, Zeineb Ben; Verges, Jean (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 243p. Dep. NTIS.

Progress on measurements and analysis of the U I and U II spectra in the past five years is reported. The present ^{238}U experimental-line list contains over 25,000 lines, of which 13,400 have a wave-number accuracy of better than 0.01 cm^{-1}. Zeeman patterns have been measured for 3350 lines, and isotope shifts for 4900 lines. More than 9000 lines have been classified to more than 900 U I levels. Levels belonging to the $5f^36d7s^2$, $5f^36d^27s$, $5f^26d^27s^2$, $5f^26d^37s$, $5f^47s^2$, $5f^37s^27p$, $5f^36d7s7p$, and $5f^36d^27p$ configurations have been identified by using isotope shift and Zeeman effect. The U II analysis contains about 2200 lines classified to more than 270 levels. Configurations with identified levels include $5f^37s^2$, $5f^36d7s$, $5f^36d^2$, $5f^36d7p$, $5f^26d7s^2$, $5f^37s7p$, $5f^26d^27s$, $5f^26d^3$, $5f^47s$, $5f^46d$, and $5f^47p$. Most levels have experimental isotope shifts and g-value data associated with them. In both U I and U II, only a very small fraction of the levels in any configuration have been found. Some theoretical calculations have been made on the energy-level structure of the low-lying configurations, and agreement is reasonably good for these levels. Those calculations lead to computed ionization potentials for U I and U II of 6.22 ± 0.5 and 10.6 ± 1 V, respectively. Only a small fraction of the total number of lines have been measured. Continued progress in the analysis depends on the acquisition of more high-precision experimental data. (auth)

5161 (ORNL-TM-3564) SOFT X-RAY STUDIES OF THE SATELLITES OF Na, Mg, Al, AND Si AND THE OPTICAL PROPERTIES OF MgO AND MgF_2. Hanson, W. F.; Arakawa, E. T. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 122p. Dep. NTIS.

Thesis. Submitted by W. F. Hanson to Univ. of Tennessee, Knoxville.

The x-ray satellites found on the high-energy sides of the $L_{2,3}$ emission bands of Na, Mg, Al, and Si have previously been attributed to the radiative decay of a double ionization state. However, in recent papers, it has been proposed that the satellites in Al and Si may arise from the simultaneous radiative decay of a core ionization state and a volume plasmon. A detailed investigation of the high-energy satellites of the $L_{2,3}$ x-ray emission bands of Na, Mg, Al, and Si was made for incident electron energies of 500 eV to 5 keV, and results were compared with the double ionization theory. Plasmon involvement is considered also. The present results lend additional support to the first interpretation, namely: that the satellite arises from the radiative decay of an atom with a double vacancy in the $L_{2,3}$ (2p) shell and not from the plasma phenomenon. Measurements of the optical properties of MgO and MgF_2 were extended from 29 to 80 eV. Reflectance and emission spectra were obtained for single crystals and transmittance spectra for thin films. The extinction coefficients for single crystals of MgO and MgF_2 are relatively large (>0.07 up to 80 eV), and sum rule calculations show the values to be reasonable. Structures in the extinction coefficients are identified as due to interband transitions from the core-electron states to the conduction bands and to excitons associated with the Mg 2p to conduction band transitions in the two materials. The optical constants are used to identify the nature of characteristic energy losses reported in the literature. The extinction coefficients of thin films of MgO and MgF_2 are less than for the single crystals. (auth)

5162 ENERGY DIFFERENCES BETWEEN TWO SPECTROSCOPIC SYSTEMS IN NEUTRAL, SINGLY IONIZED, AND DOUBLY IONIZED LANTHANIDE ATOMS. Martin, W. C. (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 61: No. 12, 1682-6(Dec 1971).

Energy differences of the type $4f^{N-1}5d-4f^N$ (doubly ionized atoms), $4f^{N-1}5d6s-4f^N6s$ (singly ionized atoms), and $4f^{N-1}5d6s^2-4f^N6s^2$ (neutral atoms) are important for the interpretation of rare-earth spectra. Here N = 1 for La, ... 14 for Yb, and each configuration is represented by its lowest level in these system differences (SD). Nineteen of these differences are now known exactly from analyses of the spectra. Five additional SD values are approximately fixed by a combination of observation and calculation. Regularities deduced from these known values allow predictions for the remaining 18 SD values. The estimated probable error for most of the predictions is either 1000 or 1500 cm^{-1}. (auth)

5163 ENERGIES OF THE ELECTRONIC CONFIGURATIONS OF THE SINGLY, DOUBLY, AND TRIPLY IONIZED LANTHANIDES AND ACTINIDES. Brewer, Leo (Univ. of California, Berkeley). J. Opt. Soc. Amer.; 61: No. 12, 1666-82(Dec 1971).

Methods are described for estimating energies of the electronic configurations of the gaseous ions of the lanthanides and actinides. Energies are tabulated for the lowest spectroscopic level of the configurations involving 4f, 5d, 6p, and 6s electrons for the lanthanide ions and 5f, 6d, 7p, and 7s electrons for the actinide ions. Some additional values are listed to be added to the previous tabulation for neutral atoms. (auth)

5164 ANALYSIS OF THE ARC SPECTRUM OF GADOLINIUM (Gd I). Van Kleef, Th. A. M. (Univ., Amsterdam); Blaise, J.; Wyart, J. F. J. Phys. (Paris); 32: No. 8, 609-15(Aug 1971).

Analysis of the Gd I spectrum led to the detection of 201 odd and 173 even levels in addition to those reported by previous investigators. The total number of classified lines is now 5300 corresponding to 5600 transitions between 236 odd and 371 even levels. The wavelength table including the Gd II lines contains over 18500 lines in the 2468 to 8752-Å wavelength region. The Zeeman effect was studied in the 2700 to 11400-Å region. Splitting was observed in about 1500 lines of the Gd I transitions; the g values corresponding to almost all the levels were determined. The odd terms belong to the electron configurations $4f^75d6S^2$, $4f^75d^26s$, $4f^75d6s7s$, and the newly established configurations $4f^75d^3$, $4f^76s6p^2$, $4f^75d^27s$, and $4f^86s6p$; the even terms are associated with $4f^76s^26p$, $4f^75d6s6p$, $4f^75d^26p$ configurations and the newly established $4f^86s^2$, $4f^85d6s$, and $4f^86s7s$. Calculations corresponding to the $4f^7(5d + 6s)^3$ and $4f^75d6s7s$ configurations are given. Values obtained for the electrostatic and spin–orbit interaction parameters gave good agreement in a least-square fit with the experimental levels. (auth)

5165 ANALYSIS OF THE SPARK SPECTRUM OF GADOLINIUM (Gd II). Blaise, J. (Centre National de la Recherche

Scientifique, Orsay, France); Wyart, J. F.; Van Kleef, Th. A. M. J. Phys. (Paris): 32: No. 8, 617-26(Aug 1971).

Analysis of wavelength data from the Gd II spectrum led to the detection of 108 odd and 70 even levels in addition to those reported by previous investigators. The total number of classified lines is now 2200; this corresponds to 2300 transitions between 162 odd and 150 even levels. The wavelength table including the Gd I lines contains over 18500 lines in the 2468 to 8752-Å region. The Zeeman effect was studied in the 2700 to 11400-Å region. About 900 lines corresponding to Gd II transitions underwent splitting. The g values were determined for all the levels. The odd terms belong to the $4f^7 5d6s$, $4f^7 6s^2$, $4f^7 5d^2$ electron configurations and the newly established $4f^8 6p$ configuration; the even terms are associated with the $4f^8 6s$ and $4f^8 5d$ (see $4f^8 6p$), $4f^7 6s6p$, and $4f^7 5d6p$ configurations. Calculations were made on the $4f^8(^7F)6s$, 5d, and 6p subconfigurations. The values of the electrostatic and spin–orbit interaction parameters gave good agreement in a least-square fit with the experimental levels. (France)

5166 A NEW METHOD FOR THE CALCULATION OF VIBRATIONAL FORCE CONSTANTS: APPLICATION TO H_2. Shipman, L. L.; Christoffersen, R. E. (Univ. of Kansas, Lawrence). Chem. Phys. Lett.; 11: No. 1, 101-4(15 Sep 1971).

A new method for the quantum mechanical calculation of vibrational force constants is presented. This method is applied to the calculation of the vibrational force constant of H_2, using a completely optimized wave function constructed from a single gaussian orbital. The value of the force constant obtained using this method is $k_0 = 0.422341088751$ a.u.($= 6.5754 \times 10^5$ dyne/cm), compared to the value of $k_0 = 0.422340795380$ a.u.($= 6.5754 \times 10^5$ dyne/cm) obtained using an analytic method and the experimental value of $k_e = 0.3692$ a.u.($= 5.748 \times 10^5$ dyne/cm). (auth)

5167 DISSOCIATION OF HYDROGEN AND n-BUTANE METASTABLE IONS BY A PULSED ION SOURCE. Matsumoto, A. (Univ. of Osaka Prefecture); Taniguchi, S.; Hayakawa, T. pp 820-7 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The dissociation of the metastable ions from H_2, HD, D_2, and n-butane was studied with a pulsed ion source. According to the present work, the metastable ions, m/e = 30.4 and m/e = 31.9, from n-butane were produced in the course of vertical transition, and the metastable ions, m/e = 0.5 from H_2, m/e = 0.33 and m/e = 1.33 from HD, and m/e = 1 from D_2, were all produced by the collision process in the ion source. The appearance potential of each hydrogen metastable ion shows an intermediate value between the ionization potential of the parent ion and the appearance potential of the fragment ion. The hydrogen metastable ions in the dissociative states may exist in a higher vibrational level of the electronic ground state of each parent ion. The dissociation of the hydrogen metastable ions will occur because the dissociating ion penetrates the potential barrier formed by the bound potential of the metastable ion and the interaction potential between the dissociating ion and the neutral particle. (auth)

5168 DISSOCIATION ENERGIES OF $He_2^+(X^2\Sigma_u^+)$ AND He_2 $(A^1\Sigma_u^+)$. Liu, B. (IBM Research Lab., San Jose, Calif.). Phys. Rev. Lett.; 27: No. 19, 1251-3(8 Nov 1971).

The configuration-interaction method is applied to calculate the dissociation energy of $He_2^+(X^2\Sigma_u^+)$, yielding a rigorous lower bound of 2.454 eV and a best value of 2.469 ± 0.006 eV. These results are used, in combination with available spectroscopic data on vibrational states of the $A^1\Sigma_u^+$ state of He_2, to unequivocally make an assignment of 2.549 ± 0.012 eV for the apparent dissociation energy and to predict a barrier height of 0.080 ± 0.018 eV for this state. (auth)

5169 ELECTRONIC ABSORPTION SPECTRUM AND U–O BOND DISTANCE OF ZINC URANYL ACETATE. Garg, C. L.; Narasimham, K. V. (Defence Science Lab., Delhi). Indian J. Pure Appl. Phys.; 9: No. 7, 459-62(Jul 1971).

The electronic absorption spectrum of zinc uranyl acetate in both the solid and liquid phases was measured. An analysis for the bands is given for the first time. The U–O force constant and bond distance were calculated with the help of Wilson's F–G matrix method and Badger's formula. The values obtained for these two parameters are 7.324 mdynes/Å and 1.73 Å, respectively. The energy-level diagram showing the various transitions in the electronic absorption spectrum is given. (auth)

5170 ACCURATE NUMERICAL HARTREE–FOCK SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR RARE-EARTH IONS HAVING $4f^N 6s$ CONFIGURATION. Saxena, K. M. S. (Univ. of Alberta, Edmonton); Malli, Gulzari. Can. J. Phys.; 49: No. 20, 2619-20(15 Oct 1971).

Accurate numerical Hartree–Fock (HF) self-consistent-field wave functions were obtained for $Ce^+(4f^2 6s)^4H$, $Pr^+(4f^3 6s)^5I$, $Nd^+(4f^4 6s)^6I$, $Pm^+(4f^5 6s)^7H$, $Sm^+(4f^6 6s)^8F$, $Eu^+(4f^7 6s)^9S$, $Gd^+(4f^8 6s)^8F$, $Tb^+(4f^9 6s)^7H$, $Dy^+(4f^{10} 6s)^6I$, $Ho^+(4f^{11} 6s)^5I$, and $Er^+(4f^{12} 6s)^4H$ rare-earth ions. In general, total energy values have an accuracy of seven significant digits. The virial theorem is satisfied to the minimum of six significant digits, and the P_{nl} wave functions are self-consistent to at least five significant figures. Several HF parameters are also evaluated with these wave functions. (auth) (Canada)

5171 ONE-ELECTRON SPECTRUM OF DOUBLY IONIZED LUTETIUM (Lu III) AND NUCLEAR MAGNETIC DIPOLE MOMENT OF ^{175}Lu. Kaufman, Victor; Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 61: No. 12, 1693-8(Dec 1971).

Thirteen new terms of the $4f^{14}(^1S_0)nl$ doublet system of Lu^{2+} were found, comprising the ns series ($7 \le n \le 10$), the nf series ($5 \le n \le 9$), and the 5g, 6d, 7d, and 7p terms. Previously, only the 5d, 6s, and 6p terms were known. The ns series was used to derive an ionization energy of 169049 ± 10 cm^{-1}. From the completely resolved hyperfine structure (hfs) of $6s^2S_{\frac{1}{2}}$, the value a(6s) = 0.436 ± 0.002 cm^{-1} was obtained for the hyperfine splitting factor. With these data, the nuclear magnetic dipole moment μ_I was found to be 2.204 ± 0.010 μ_N, where the stated uncertainty includes only the experimental uncertainty for a(6s). (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 5612, 5762, 5788, 5846, and 6056.

5172 QUADRATIC hfs PRESSURE SHIFTS OF MUONIUM IN ARGON AND KRYPTON. Favart, D. (Univ. of Chicago); McIntyre, P. M.; Stowell, D. Y.; (and others). Phys. Rev. Lett.; 27: No. 20, 1340-2(15 Nov 1971).

The very precise, low-pressure measurements of the hfs interval Δν(p) of muonium in Ar and Kr described in the preceding letter (Phys. Rev. Lett. 27: 1336-40(1971)) are combined with the high-pressure measurements from Yale to determine the magnitude of quadratic pressure shifts. Fitting by the form $\Delta\nu = \Delta\nu(0)[1 + ap + bp^2]$, it is found that b(Ar) = 7.1(2.3) and b(Kr) = 8.7(3.1) (in units of 10^{-15} $torr^{-2}$). Older evidence for these quadratic shifts from similar fits involving earlier Chicago data is reviewed. (auth)

5173 PRECISION MEASUREMENT OF THE HYPERFINE INTERVAL OF MUONIUM BY A NOVEL TECHNIQUE: RAMSEY RESONANCE IN ZERO FIELD. Favart, D. (Univ. of Chicago); McIntyre, P. M.; Stowell, D. Y.; (and others). Phys. Rev. Lett.; 27: No. 20, 1336-40(15 Nov 1971).

A novel method for measuring the hyperfine interval Δν of muonium in "zero" magnetic field is described. It consists in applying two successive coherent microwave pulses (lengths τ, separation T) to muonium and observing the change in muon polarization at $t > T + 2\tau$. By extrapolating two low-pressure runs in Kr a value of Δν(0) = 4463.3013(40) MHz is obtained, whereas a joint fit with earlier Chicago Kr data gives Δν(0) = 4463.3012(23) (0.5 ppM). With $f_\mu/f_p = 3.183\,338(13)$ this implies (a) $\alpha^{-1} - 137 = 0.036\,19(30)$ (2.2 ppM) and (b) a proton polarizability $\delta_N^{(2)} = -(4 \pm 4)$ ppM. (auth)

5174 RADIATIVE CORRECTIONS TO DECAY OF ORTHO-POSITRONIUM. Holt, John Macdonald. New Haven; Yale Univ. (1971). 143p. University Microfilms Order No. 71-22,350. Thesis.

The matrix element for orthopositronium decay is analyzed. An approximate matrix element is derived by selectively summing the Feynman diagrams for the decay of an electron–positron pair. This approximate matrix element includes all terms of order α relative to the lowest-order matrix element. The terms due to self-energy and vertex corrections are evaluated numerically. The remaining three terms are put in a form suitable for numerical evaluation. (TSS)

Collision Phenomena

5175 (ORO–2591-61) FORMATION OF EXCITED HYDROGEN ATOMS BY CHARGE TRANSFER AND DISSOCIATION. Progress Report No. 7, December 1, 1970–November 30, 1971. Thomas, E. W.; Ford, J. C.; Fitzwilson, R. L.; Sauers, I.; Conrads, R. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-2591. 25p. Dep. NTIS.

Progress is reported on studies of the following: (1) total cross sections for the formation of the 3s, 3p, and 3d states of hydro-

gen by impact of H^+, H_2^+, and H_3^+ on gases at projectile energies of 75 to 1000 keV, (2) angular distributions of H(2s) formed by charge transfer and dissociation when H^+ and H_2^+ are incident on H_2 and Ar at 5 to 30 keV, and (3) formation of excited hydrogen atoms by H^+, H_2^+, and H_3^+ impact on metal surfaces. Included in this report are a brief statement of the experimental method used, a list of the reactions studied, a summary of the more important conclusions, and a list of publications containing the detailed results. (A.G.W.)

5176 (SRIA-115-P-84-2) ELASTIC AND INELASTIC SCATTERING IN THE Li^+ + He SYSTEM. Technical Report No. 2. Lorents, Donald C.; Conklin, George M. (Stanford Research Inst., Menlo Park, Calif.). 6 Jul 1971. Contract AT(04-3)-115. 35p. Dep. NTIS.

Experimental studies of the Li^+ + He interaction were extended to smaller internuclear separations to clarify a discrepancy between experiment and theory in the elastic cross sections and to observe and measure cross sections for inelastic excitation. For $R \leq 0.5\ a_0$ the elastic-scattering differential cross section is observed to drop far below that expected from a single-state interaction based on ab initio ground-state potentials. In this same region of R both one- and two-electron excitations of He are observed to be strongly excited, and cross sections were measured for each of them. The lowest inelastic channel is an electron-capture state, which is observed indirectly to be strongly populated also. A diabatic correlation diagram is constructed, which exhibits the basic interactions responsible for the excitation. (auth)

5177 MEASUREMENTS OF ENERGY AND ANGULAR DISTRIBUTIONS OF SECONDARY ELECTRONS PRODUCED IN ELECTRON-IMPACT IONIZATION OF HELIUM. Peterson, William Kenneth. Boulder, Colo.; Univ. of Colorado (1971). 139p. University Microfilms Order No. 71-25,864.

Thesis.

Energy and angular distributions of secondary electrons produced in electron-impact ionization of helium were measured in a crossed-beam apparatus. Secondary electrons were analyzed in a hemispherical electrostatic analyzer with a broad energy resolution ($\Delta E/E \approx 0.09$), and an angular acceptance of 15°. The results are presented as cross sections differential in secondary energy (4 to 200 eV) and angle of ejection (30° to 150°) with respect to the direction of the primary electron beam. Measurements were made for primary energies between 50 and 2000 eV and were normalized to the 100-eV elastic scattering cross section. The results were integrated over angle and energy to give total ionization cross sections. These agreed, to within experimental error, with previous measurements. The angular distributions were nearly isotropic for low-energy secondary electrons (less than 25 eV) and had a pronounced maximum between 45° and 90° at higher secondary energies. The position of the maximum could be calculated by using conservation of energy and momentum, assuming that relatively little momentum was transferred to the ion. Regularities in the observed energy and angular distributions implied that the average momentum imparted to the ion was almost independent of the primary electron's energy for primary energies above 200 eV. The secondary-electron distributions were integrated over all angles of ejection to give cross sections for production of secondary electrons differential only in the secondary-electron energy. These distributions were compared with various calculations both including and omitting exchange effects due to the indistinguishability of the secondary electron and the degraded primary electron. Better agreement was found with the calculations including exchange effects. (Diss. Abstr. Int., B)

5178 LOW-ENERGY ELECTRON SCATTERING BY MAGNESIUM. Van Blerkom, Janet Kay. Boulder, Colo.; Univ. of Colorado (1971). 101p. University Microfilms Order No. 71-25,879.

Thesis.

The electron scattering cross sections for the three lowest states of Mg I are calculated using the close-coupling approximation with a semi-empirical core potential. Configuration interaction is included in the Mg I wave functions. Several resonances occur, a few of which strongly affect the total cross sections. Three elastic cross sections (3^1S-3^1S, 3^3P-3^3P, 3^1P-3^1P) and three inelastic cross sections (3^1S-3^3P, 3^1S-3^1P, 3^3P-3^1P) are presented. A table of collisional rates versus temperature and a brief discussion of astrophysical applications are also included. (Diss. Abstr. Int., B)

5179 LOW-ENERGY ELASTIC AND FINE-STRUCTURE EXCITATION SCATTERING OF $C^+(^2P)$ BY $H(^2S)$. Weisheit, Jon Carleton. Houston, Tex.; Rice Univ. (1971). 124p. University Microfilms Order No. 71-26,372.

Thesis.

Cross sections are computed for the elastic and fine-structure excitation scattering of singly ionized carbon by low-energy (less than .1 eV) hydrogen atoms. For the first time, both spin-change and long-range electrostatic interactions are included in a close-coupling calculation of scattering cross sections. The scattering equations are solved in a coupled-angular-momentum representation, allowing for the energy defect between the $C^+(^2P_j)$ fine-structure levels. The calculated C^+-H excitation cross section varies from 174 a_0^2 at .01 eV to 102 a_0^2 at .085 eV, and the maximum of almost 200 a_0^2 occurs near .015 eV. At all energies considered, it is found that the spin-change interaction is more important than the long-range electrostatic interaction, and also that the C^+-H spin-change excitation cross section computed by Smith (1966) is approximately 20% larger than that calculated here. The numerical techniques used are described in detail, and the sensitivity of the results to these techniques is examined. (Diss. Abstr. Int., B)

5180 STUDY OF THE POLARIZED ORBITAL METHOD AND ITS APPLICATION TO THE SCATTERING OF ELECTRONS BY HELIUM. Duxler, William Morris. Riverside, Calif.; Univ. of California (1971). 126p. University Microfilms Order No. 71-27,084.

Thesis.

A study was made of the polarized-orbital method (POM) for electron–atom scattering. Within this framework an exact calculation was carried out for the electron–helium–atom case. This study confirms the importance of the second-order distortion exchange terms, which provide a nonadiabatic effect. A study is made of the much-criticized step function, and its inclusion within the POM framework is found not to be crucial. An attempt is made to clear up some of the present confusion in the literature by distinguishing between the POM and related methods. (Diss. Abstr. Int., B)

5181 FADDEEV EQUATIONS AND THE FADDEEV-WATSON MULTIPLE SCATTERING EXPANSION FOR THREE-BODY ATOMIC PROBLEMS. Kramer, Paul John. San Diego, Calif.; Univ. of California (1971). 167p. University Microfilms Order No. 71-26,575.

Thesis.

In Part I, the Faddeev equations are reduced to a set of coupled single-variable integral equations using a partial-wave expansion and the separable expansion of the off-shell two-body Coulomb amplitude in terms of Sturmian functions. After consideration of boundary conditions, application is made to the (e^-, H) systems for energies in the elastic scattering and three-body bound-state regions. The results for scattering length and phase shift are compared with those obtained by other methods. The three-body bound state and resonance obtained for the (e^+, H) system using only the first few terms in the separable expansion are shown to disappear when more terms are included in the expansion. In Part II, a three-body multiple scattering expansion is derived from the Faddeev equations for rearrangement processes. The Born and first-order matrix elements are evaluated using a closed form of the off-shell two-body Coulomb T-matrix. Physically, it can be shown that the contributions to the three-body scattering amplitude come from (1) the bound-state poles in the initial and final wave functions, (2) the branch-point singularities, (3) the intermediate two-body antibound-state poles in the off-shell two-body Coulomb T-matrix. The behavior of the first-order multiple-scattering amplitude and the differential and total cross sections calculated to this order are presented and compared to the differential and total cross sections calculated in the Born and Jackson–Schiff approximations for the (p^+, H), (e^+, H), (e^+, (e^-e^+)), and (p^+, ($e^-\mu^+$)) systems. (Diss. Abstr. Int., B)

5182 ROTATIONAL AND VIBRATIONAL EXCITATION OF MOLECULES BY ATOM IMPACT. Tsien, Thomas P. Provo, Utah; Brigham Young Univ. (1971). 95p. University Microfilms Order No. 71-24,303.

Thesis.

The quantum mechanical theory of rotational and vibrational transitions in atom–diatom systems is investigated and summarized. The time-independent scattering formalism of Arthurs and Dalgarno is used, and the degeneracy-averaged cross section is expressed in terms of the scattering S matrix. The major emphasis is on the solution of the rotationally strongly coupled differential equations. Various methods of solving the scattering equations are examined, and some of the inadequacies of these methods are discussed. A strong-coupling (SC) approximation, valid for small energy exchange, is introduced and tested numerically on some model problems. A first order iteration to the SC approximation is presented to improve the SC approximation and to extend the range of validity to cases of larger energy exchange. The SC results are compared with the accurate numerical solution and other approximate methods for some model problems. The comparison clearly demonstrates that the SC approximation is the computationally fastest, reasonably reliable method known

for computing rotationally inelastic cross sections. (Diss. Abstr. Int., B)

5183 ENERGY-LOSS MEASUREMENTS OF K^+ IONS IN HEAD-ON COLLISIONS WITH He, H_2, AND D_2. Van Dop, H.; Boerboom, A. J. H.; Los, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 54: No. 2, 223-36 (31 Aug 1971).

Energy losses of K^+ ions in head-on collisions with He, H_2 and D_2 were determined. For K^+ on He only elastic scattering was observed in a laboratory energy range from 250 to 2500 eV. Cross sections for this process were measured as a function of energy. From the energy dependence of the cross section the steepness of the repulsive interaction potential was determined. Using an inverse-power model, $V(r) = K/r^s$, s was to be 2.2 ± 0.2, over the investigated range of interaction $0.3\ Å \leq r \leq 0.6\ Å$. The collisions of K^+ with H_2 and D_2 show inelastic energy losses due to vibrational excitation of the molecules. The experimentally observed inelastic energy transfer is compared with calculations based on a model of a collinear collision of a particle with a harmonic oscillator. Below 22 eV center-of-mass energy there is good agreement between theory and experiment. At higher energies theory predicts too low values for the energy transfer, probably because it overestimates the importance of multistep collisions with the harmonic oscillator. Above 26 eV, energy losses corresponding with impulsive stripping collisions are also observed. For a better theoretical description a two- or three-dimensional collision model should be used. (auth)

5184 ANGULAR DISTRIBUTION OF ELECTRONS EJECTED BY CHARGED PARTICLES. II. THE BINARY-ENCOUNTER POLARIZED-ORBITAL METHOD. Bonsen, T. F. M. (State Univ., Utrecht); Vriens, L. Physica; 54: No. 2, 318-24(31 Aug 1971).

Cross sections for ejection of electrons from helium by 100- to 300-keV protons were calculated with a combined binary-encounter polarized-orbital method. The resulting cross sections are shown to be in better agreement with experiment than those obtained with the binary-encounter theory alone. Remaining discrepancies are discussed in some detail. (auth)

5185 MULTIPLE IONIZATION AND AUGER TRANSITIONS INDUCED IN In AND Ag BY ELECTRON BOMBARDMENT. Abouaf, R. (Paris Univ., Orsay, France). J. Phys. (Paris); 32: No. 8, 603-8(Aug 1971). (In French).

Ag and In were bombarded with electrons, and the relative impact cross sections corresponding to the Ag^{7+} and In^{8+} states of ionization were measured. The results obtained for the Ag^{2+}/Ag^+ ratio with electron energies of 75 and 1000 eV are in good agreement with the results of Crawford et al. Multiply charged ions ($n \geq 5$) are copiously produced by Auger processes; these processes are the principal source of the highly charged ions (In^{7+}, In^{8+}, Ag^{7+}). Most of the results indicate supplementary electron ejection, occurring either during the primary ionization (In^{5+}, In^{6+}, Ag^{5+}, Ag^{6+}) or during the Auger transition cascade (In^{7+}, Ag^{7+}). (France)

5186 HEURISTIC THEORY OF POSITRON–HELIUM SCATTERING. Drachman, R. J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Lett.; 37A: No. 3, 187-8(22 Nov 1971).

An L-dependent local potential is constructed to fit the well-known positron–hydrogen s-, p-, and d-wave phase shifts below the rearrangement threshold. The same form of potential yields a positron–helium cross section in agreement with a recent experimental measurement near threshold. (auth)

5187 MASS SPECTROSCOPIC RESEARCHES ON ATOMIC AND MOLECULAR COLLISIONS. Ewald, H.; Seibt, W. (Justus-Liebig Univ., Giessen, Ger.). pp 39-59 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Some characteristic examples of the use of mass spectroscopy in studies of atomic and molecular collisions are reviewed. The studies are divided into three groups: (1) coincidence measurements of single collisions of atomic ions and atoms, (2) collision-induced dissociations of diatomic ions, and (3) reactions of ions of low kinetic energy with atoms and molecules. (51 references) (A.G.W.)

5188 IONIZATION OF METAL ATOMS BY ELECTRON IMPACT. Okudaira, S.; Nagata, T.; Okuno, Y.; Kaneko, Y.; Kanomata, I. (Tokyo Metropolitan Univ.). pp 769-74 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The absolute cross section of total ionization of Mg and ionization efficiency curves for Mg, Ca, Sr, and Ba were measured by crossed-beam methods at electron energies of 22.4, 106.5, 492, and 1000 eV. Ionization efficiency curves near threshold for doubly charged ions of Mg, Ca, Sr, and Ba were measured by a different method. The structures in the multiple-ionization curves are attributed to various ionization mechanisms, namely, direct ionization, autoionization, and Auger processes. The relative abundances of multiply charged ions were determined. (A.G.W.)

5189 IONIZATION CROSS SECTIONS OF THE ELEMENTS. Mann, J. B. (Los Alamos Scientific Lab., N. Mex.). pp 814-19 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

An empirical method for predicting cross sections for electron-impact ionization of all elements is proposed. The method is based loosely on Bethe's equations developed from the Born approximation. Calculated cross-section maxima and the energies at which the maxima occur are tabulated for the first 95 elements. Results are compared with experimental measurements. (A.G.W.)

5190 COLLISION-INDUCED IONIZATION OF HIGHLY EXCITED ARGON IONS. Okuno, K.; Kaneko, Y.; Kanomata, I. (Tokyo Metropolitan Univ.). pp 830-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Cross sections are reported for the reactions $Ar^{+*} + Ar \rightarrow Ar^{2+} + Ar + e$ and $Ar^{+*} + N_2 \rightarrow Ar^{2+} + N_2 + e$, in which the product Ar^{2+} ion appears at m/e = 10, and for the reactions $Ar^{2+} + Ar \rightarrow Ar^+ + Ar^+$ and $Ar^{2+} + N_2 \rightarrow Ar^+ + N_2^+$, in which the product Ar^+ ion appears at m/e = 80. Total attenuation cross sections of Ar^+ and Ar^{2+} in Ar and N_2 are included. Possible mechanisms leading to the appearance of the metastable peak at m/e = 10 are discussed. (A.G.W.)

5191 ELECTRON–ION COLLISION STUDIES WITH SUPERIMPOSED BEAMS. Theard, L. P. (McDonnell Douglas Corp., Huntington Beach, Calif.). pp 875-80 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

An instrument built for study of electron–ion collisions at interaction energies down to a few tenths of an electron volt by the method of superimposed beams is described. The apparatus is currently being used to study dissociative electron–ion recombination reactions of the type $M^+ + e \rightarrow N_1 + N_2 + \ldots\ldots + N_n$, where M^+ is a polyatomic ion, e is a free electron, and N_1, N_2, and N_n are neutral products of the reaction. Results from the reaction $N_2^+ + e \rightarrow N + N$ with a contribution from the process N_2^+ (fast) + $N_2 \rightarrow N_2$ (fast) + N_2^+ are included as an example. (A.G.W.)

5192 PROTON–NITROGEN COLLISIONS LEADING TO PRODUCTION OF METASTABLE 2s HYDROGEN ATOMS. Jaecks, D. H.; Crandall, D. H.; McKnight, R. H. (Univ. of Nebraska, Lincoln). pp 881-2 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The cross sections for production of metastable H(2s) atoms in collisions of 1- to 21-keV protons with N_2 were measured. The low-energy region of the data does not show a distinct maximum but does show a definite enhancement of the cross section. These results suggest that molecular targets with closed electron shells such as nitrogen can be treated as similar to closed-shell atomic targets when calculating total charge-transfer cross sections in this energy range. (A.G.W.)

5193 ANGULAR DISTRIBUTION OF PHOTOELECTRONS FROM DIFFERENT ROTATIONAL $H_2 \rightarrow H_2^+$ TRANSITIONS. Niehaus, A.; Ruf, M. W. (Univ., Freiburg i. B.). Chem. Phys. Lett.; 11: No. 1, 55-7(15 Sep 1971).

Spectra of photoelectrons arising from $H_2(^1\Sigma_g^+) \rightarrow H_2^+(^2\Sigma_g^+)$ transitions induced by Ne (736-Å) resonance photons are vibrationally and, partly, rotationally resolved and measured as functions of angle with respect to the photon beam. From these data anisotropy parameters β for the $(v'' = 0) \rightarrow (v' = 1)$, $\Delta N = 0$, and $\Delta N = 2$ transitions are determined. (auth)

5194 THEORY OF COLLISION-INDUCED DISSOCIATION. Levine, R. D. (Hebrew Univ., Jerusalem). Chem. Phys. Lett.; 11: No. 1, 109-12(15 Sep 1971).

The probability for collision-induced dissociation near the energy threshold is shown to increase exponentially with the initial vibrational energy of the diatomic molecule, in agreement with the experiment of Tully et al. At higher collision energies the effect is less pronounced and, at sufficiently high energy, is in the opposite direction. (auth)

5195 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION FOR ARGON–KRYPTON SCATTERING. Bredewout, J. W.; Bosman, N. J.; Visser, A. G.; Korving, J.; van den Meijdenberg, C. J. N. (Univ. of Leiden). Chem. Phys. Lett.; 11: No. 1, 127-30(15 Sep 1971).

The velocity dependence of the total cross section for scattering of an argon beam by krypton was measured for relative velocities ranging from 550 to 4300 m/sec. From the location of five well-resolved glory extrema the product of the potential parameters ϵ and r_m could be determined accurately. (auth)

5196 ELECTRON-IMPACT EXCITATION FUNCTIONS OF RADIATING AND METASTABLE STATES OF CARBON MONOXIDE. Newton, A. S.; Thomas, G. E. (Univ. of California, Berkeley). Chem. Phys. Lett.; 11: No. 2, 171-4(1 Oct 1971).

Excitation functions near threshold were measured for the production of photons and for the production of long-lived metastable molecules from carbon monoxide. An interesting peaked feature exists at the threshold for photon production. (auth)

5197 EFFECT OF THE TRAJECTORY DISTORTION ON THE DEPOLARIZING COLLISIONS OF ATOMS. Dashevskaya, E. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Chem. Phys. Lett.; 11: No. 2, 184-5(1 Oct 1971).

The matching approximation is used to calculate the depolarizing probability of atoms, taking into account distortion and "branching" of the relative motion trajectory. (auth)

5198 ELECTRON-IMPACT CROSS SECTIONS AND RATES FOR $nl \rightarrow n'l'$ TRANSITIONS IN HYDROGENIC IONS AND HYDROGEN. Golden, Lawrence B.; Sampson, Douglas H. (Pennsylvania State Univ., University Park). Astrophys. J.; 170: No. 1, 181-90 (15 Nov 1971).

Calculations of Coulomb–Born cross sections were made for the $2l \rightarrow 3l'$ transitions for $Z = 2$, for the $1s \rightarrow 3l'$ transitions for $Z = 2$ and $Z = \infty$, and for the $1s \rightarrow 2l'$ transitions at threshold for $Z = 2, 3, 5$, and ∞. These results, together with other available cross-section data and earlier work on $n \rightarrow n'$ transitions, were used in obtaining semi-empirical electron-impact cross sections and rates for transitions of the kind $nl \rightarrow n'l'$ in hydrogenic ions and hydrogen. (auth)

5199 ENERGY TRANSFER IN ELECTRON-EXCHANGE REACTIONS AT LOW KINETIC ENERGIES. Maher, K. E.; Leventhal, J. J. (Univ. of Missouri, St. Louis). Phys Rev. Lett.; 27: No. 19, 1253-6(8 Nov 1971).

The energy transferred in single-electron-exchange processes in Ar^{++}–He and Ar^{++}–D_2 collisions was experimentally determined for relative kinetic energies below 9 eV (cms). The results confirm the "nearest-resonance" hypothesis for these two representative systems. (auth)

5200 ION SCATTERING. III. RAINBOW EFFECTS WITH SCATTERING OF H^+ ON N_2, CO, CO_2, SF_6, H_2, AND CH_4 AND H_2^+ ON Ar AND Kr. Mittmann, H.-U.; Weise, H.-P.; Ding, A.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26a: No. 8, 1282-9(Aug 1971). (In German).

Differential scattering cross sections of H^+ on various molecules and of H_2^+ on Ar and Kr were measured at various energies between 5 eV and 40 eV. Several rainbows could be resolved for the systems H^+–N_2, H^+–CO, H^+–CO_2 and H^+–SF_6. In the case of H^+–H_2, secondary rainbows could be traced at higher energies (30 eV). Only the primary rainbow was observed for H^+–CH_4. The H_2^+–Ar and H_2^+–Kr systems also yielded rainbow structures. Broad additional maxima appeared at large angles for H_2^+–Kr, which were attributed to the crossing of potential curves. The rapid oscillations could not be observed. The measured differential cross sections for the systems H^+–N_2, CO, CO_2, SF_6, and H_2 were fitted by a procedure described in Part I using a simple Morse potential. The equilibrium distances r_m were estimated from the relation $r_m = 0.7 \cdot r_g$ (r_g = gas-kinetic radius of the molecule) which was found to hold approximately for the H^+-noble gas systems. The following potential depths ϵ were obtained: 4.15 eV for N_2–H^+; 4.70 eV for CO–H^+; 5.10 eV for CO_2–H^+; 3.66 eV for SF_6–H^+; 4.04 eV for H_2–H^+. These values are averages because of the anisotropy of the potentials. The potential depth for the H^+–H_2 system is little smaller than the theoretical value of 4.56 eV. This is attributed to nontriangular configurations in the scattering process. The scattering experiments with the system H^+–CH_4 were evaluated classically. ϵ (H^+–CH_4) was found to be only 3.8 eV. The large difference from the theoretical value $\epsilon = 5.45$ eV is explained by the inadiabacity of the scattering process with respect to the movement of the H atoms in methane. ϵ (Ar–H_2^+) and ϵ (KrH_2^+) were found to be (1.3 ± 0.2) eV and (1.1 ± 0.2) eV, respectively. Energy-level diagrams are discussed for the ion–molecule reactions $Ar^+(Kr^+) + H_2 \rightarrow ArH^+(KrH^+) + H$ including the ArH_2^+ and KrH_2^+ intermediate states. They show that most of the reaction energy becomes free in the approach of the reactants $Ar^+ + H_2$. This effect is less pronounced for the $Kr^+(^2P_{\frac{1}{2}}) + H_2$ reaction, and even a small threshold energy exists for the $Kr^+(^2P_{\frac{3}{2}}) + H_2$ reaction. (auth)

5201 POLARIZED ORBITAL CALCULATIONS OF POSITRON COLLISIONS WITH LITHIUM ATOMS. Bui Tien Dai; Stauffer, A. D. (York Univ., Toronto). Can. J. Phys.; 49: No. 20, 2527-31(15 Oct 1971).

The collision of positrons with lithium atoms is treated by the polarized-orbital method. Results of calculations for the elastic and diffusion cross sections, Z_{eff}, and the angular correlation function are given. (auth) (Canada)

5202 MEASUREMENTS OF THE PRIMARY IONIZATION COEFFICIENT IN H_2. Blasberg, H. A. M.; de Hoog, F. J. (Technische Hogeschool, Eindhoven, Netherlands). Physica; 54: No. 3, 468-72(15 Sep 1971).

Measurements were made in a non-self-sustained Townsend discharge by a light-detection method. Consider a pair of infinite plane parallel electrodes a distance d apart. The electron current leaving the cathode will ionize gas molecules and produce an electron avalanche. One assumes the electrons to be in equilibrium with the applied homogeneous electric field in the gas. The light-detection method makes use of the property of this discharge that the radiant flux emitted by an elementary volume is proportional to the electron density. According to Townsend's theory this density increases exponentially with distance and can be written as $n(x) = n(0) \exp(\alpha x)$, where $n(0)$ is the electron density at a plane $x = 0$ perpendicular to the axis of the discharge. Thus measuring the radiant flux as a function of the position in the discharge, one acquires the primary ionization coefficient from the relative increase of the local electron density. The main object of the performed experiments was to compare the values of α/p_0 determined by the light-detection method with those obtained by the well-known Townsend method, in which d is varied and the discharge current is measured. (auth)

5203 MULTIPLE IONIZATION OF He AND Ne BY 10-keV ELECTRONS AS A FUNCTION OF THE ENERGY LOSS. van der Wiel, M. J.; Wiebes, G. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 54: No. 3, 411-24(15 Sep 1971).

Oscillator-strength spectra are reported for transitions to the $He^{1+,2+}$ and Ne^{1+-3+} continua. The spectra, covering a range of energy transfers from threshold up to 250 eV, were derived from the small-angle, inelastic scattering of 10-keV electrons in these gases, observed in coincidence with the ions. The data show that the ratio of double and single ionization passes through a maximum before approaching the asymptotic value at high-energy transfers. This result is in disagreement with earlier photoionization experiments, but it supports recent theoretical work on double ionization in He. (auth)

5204 SEMI-EMPIRICAL CROSS SECTIONS AND RATES FOR EXCITATION AND FOR IONIZATION OF HYDROGENIC IONS BY ELECTRON IMPACT. Sampson, Douglas H.; Golden, Lawrence B. (Pennsylvania State Univ., University Park). Astrophys. J.; 170: No. 1, 169-80(15 Nov 1971).

Semi-empirical electron-impact cross-sections and rates are given for hydrogenic ions of any Z both for ionization and for excitation of the type $n \rightarrow n'$, where n and n' are the initial and final principal quantum numbers. The results are written in a form similar to and involving the same parameters as earlier work on hydrogen. For ionization, the results are quite similar to Percival's proposal; however, for excitation they are usually slightly larger for $n \rightarrow n + 1$ transitions and considerably larger for $n \rightarrow n' > n + 1$ transitions than most previous proposals. (auth)

Atomic Theory

5205 (CEA-R-4231) INTERACTION POTENTIAL AND REPULSIVE FORCE BETWEEN ATOMS WHOSE INTERNUCLEAR SEPARATIONS ARE SMALL. Barbaro, Jacques (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Sep 1971. 62p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France).

The Thomas–Fermi equation is solved for the homonuclear

diatomic molecule. The electron density and electrostatic potential at each point are used to calculate energies and interaction potentials for very small internuclear separation distances. The repulsive force between atoms is derived by means of the virial theorem. (France)

5206 (INR-P-1320) SUPERRADIANT STATES IN TWO-LEVEL AND HARMONIC OSCILLATOR SYSTEMS. Zakowicz, Wladyslaw (Institute of Nuclear Research, Warsaw (Poland)). 1971. 7p. Dep. NTIS (U. S. Sales Only).

A comparison of superradiant states for the systems of two-level atoms and harmonic oscillators is given. For weak excitations some similarities between these states are pointed out. (auth)

5207 (JINR-P4-5933) ON THE CALCULATION OF THE NATURAL WIDTH OF THE SPECTRAL LINES OF THE ATOM BY THE METHODS OF NONEQUILIBRIUM STATISTICAL MECHANICS. Kuzemskii, A. L.; Walasek, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. (In Russian). Dep. NTIS.

The natural widths of the spectral lines of atomic systems were calculated on the basis of the Schroedinger-type equation with damping for the dynamical system in a thermal bath, obtained on the basis of the method of the nonequilibrium statistical operator. (auth)

5208 PROGRAM FOR CALCULATING THE STATIC INTERACTION POTENTIAL BETWEEN AN ELECTRON AND A DIATOMIC MOLECULE. Faisal, F. H. M. (Goddard Space Flight Center, Greenbelt, Md.); Tench, A. L. V. Comput. Phys. Commun.; 2: No. 5, 261-71(Aug-Sep 1971).

The program described calculates the single-center multipole expansion of the static potential for a diatomic molecule. It also calculates the dipole and quadrupole moments. The molecular orbitals are assumed to be given by an LCAO MO SCF wave function obtained from a basis set of Slater-type atomic orbitals around the two nuclei of the molecule. These are expanded in Legendre polynomials around the center of mass. The resulting wave functions are normalized and used to calculate the static potential. (A.G.W.)

5209 GENERALIZED FORM OF ATOMIC TWO-ELECTRON INTEGRALS OVER HYDROGENIC FUNCTIONS. Joshi, Bhairav D. (State Univ. of New York, Geneseo). J. Comput. Phys.; 8: No. 2, 300-3(Oct 1971).

A computationally useful form of the general two-electron atomic integral over hydrogenic functions is presented. The formulas given are general enough to allow the variation of the exponential parameter should it be desired. The same formulas are also valid when Slater-type functions are used provided certain conditions are fulfilled. The formulas are particularly suited for a high-speed digital computer. (A.G.W.)

5210 A PROPERTY OF GAUSSIAN WAVE FUNCTIONS. Tsapline, B. (Battelle Inst., Geneva). Chem. Phys. Lett.; 11: No. 1, 75-81(15 Sep 1971).

Short-range behavior of gaussian wave functions is analyzed in terms of momentum expectation values. Qualities and properties of some functions, which illustrate the various schemes generally used to build up gaussian basis sets, are discussed in detail for some atomic systems. (auth)

5211 PROGRAM FOR ATOMIC WAVEFUNCTION COMPUTATIONS BY THE PARAMETRIC POTENTIAL METHOD. Klapisch, M. (Laboratoire Aime Cotton, Orsay, France). Comput. Phys. Commun.; 2: No. 5, 239-60(Aug-Sep 1971).

The program MAPPAC computes atomic radial wave functions and many related quantities such as Slater integrals, spin–orbit coupling, mixing of configurations, hyperfine structure, transition probabilities, etc., in the framework of first-order perturbation theory built upon an optimized central field. The central field is represented by an analytical expression in which some parameters are free. Given initial values of these, an iterative computation is performed, which optimizes the central field according to one of several quality criteria. Any atom or ion can be studied except for those involving g-wave and higher-wave electron orbitals. (A.G.W.)

Cosmic Radiation

Refer also to abstracts 4588, 5112, 5116, 5130, 5265, 5690, 5709, 5711, 5718, 5719, 5781, 5782, 5796, and 5800.

5212 (N-71-34952) MEASUREMENTS OF THE NEUTRON INTENSITY IN SPACE. Final Report. Lockwood, J. A. (New Hampshire Univ., Durham. Dept. of Physics). Jun 1971. 21p. (NASA-CR-121629). NTIS.

Balloon and rocket flight activities have emphasized: (1) measurements of the fast neutron flux and energy spectrum near the top of and above the atmosphere; (2) measurements of the gamma-ray flux and energy spectrum in the energy interval 0.5 to 10 MeV simultaneously on the same flights; (3) extension of the energy range of the neutron and gamma-ray detectors; and (4) completion of a rocket flight to measure the fluxes of neutrons, gamma rays, x rays (0.1 to 2.0 A), and low-energy charged particles above the atmosphere. (auth) (STAR)

5213 (N-71-34953) EXPERIMENT ON S57 (LATER OSO 3) SATELLITE (COSMIC RAY CHARGE AND ENERGY SPECTRA). Final Report. Kaplon, Morton F. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Jun 1971. Contract NAS5-3178. 66p. (NASA-CR-121626). NTIS.

The results of the S-57 (later OSO-3) investigation of the high-energy charged component in a distortion free atmosphere are reported. Details of the detector design and operation are given, and results are reported in tabular form. Some of the objectives for which results are reported included: the charge composition of the quiescent cosmic radiation; the integral energy spectrum of all components; the charge composition of solar-flare emitted beams within the various components; the cosmic-ray albedo, both the splash and re-entrant type; modulation of the intensities of protons and He nuclei as a function of time; and the detection of high-energy gamma rays of celestial origin. (STAR)

5214 (NP-19103) RELATIVE ABUNDANCE OF THE CARBON ISOTOPES ^{12}C AND ^{13}C IN PRIMARY COSMIC RADIATION. Joensson, G.; Kristiansson, K.; Malmqvist, L. (Lund Univ. (Sweden). Dept. of Physics). Feb 1970. 49p. (KS-7002). Dep. NTIS (U. S. Sales Only).

Mass measurements were performed on cosmic-ray carbon nuclei stopped in a nuclear emulsion stack exposed to the primary radiation in a high-altitude balloon flight. The mass determinations were based on measurements of mean track width and residual range in the range intervals $0 < R < 0.75$ mm and $1 < R < 12$ mm. The mean-track-width measurements were performed with nuclear track photometers. The mass measurements in the interval $0 < R < 0.75$ mm gave a nearly symmetrical mass distribution. The width of the distribution was equal to that expected for a distribution containing only one isotope. The result indicated that one of the stable isotopes was appreciably more abundant than the other. The isotopic ratio $^{13}C/(^{12}C + ^{13}C)$ was found to be 0.08 in the range interval $1 < R < 12$ mm. The ratio was extrapolated to the cosmic-ray source. It was found to be smaller in the source than at the point of measurement. Different assumptions about the origin of cosmic radiation are discussed with regard to the results obtained in this investigation. (Sweden)

5215 (NP-19111) MASS RESOLUTION IN INVESTIGATIONS OF THE ISOTOPIC COMPOSITION OF HEAVY ELEMENTS IN COSMIC RADIATION. Malmqvist, L. (Lund Univ. (Sweden). Dept. of Physics). Apr 1970. 19p. (KS-7006). Dep. NTIS (U. S. Sales Only).

The mass resolution that can be expected in mass measurements of cosmic-ray particles stopped in a stack of nuclear emulsions was investigated. The mass determinations were based on accurate measurements of the relation between track width and residual range. The results show that it is possible to perform a mass measurement with a standard error less than 0.5 atomic mass units for nuclei in the charge interval $4 \leq Z \leq 12$ if a track length of about 10 mm is available for measurement. (Sweden)

5216 SEARCH FOR ANISOTROPIES IN COSMIC-RAY SOURCES BETWEEN 9^0 AND 69^0 DECLINATION. Carreira, Emmanuel M. Washington, D. C.; Catholic Univ. of America (1971). 136p. University Microfilms Order No. 71-25,023. Thesis.

A survey of the distribution of cosmic-ray sources was carried out by means of a spark chamber, which allowed the determination of the incoming direction of secondary cosmic ray particles (muons). From the analysis of 39,111 events, a map of the sky was drawn in terms of the relative number of tracks originating within each given area. The resulting pattern seems to indicate a direct relationship between cosmic-ray flux and the structure of the Galaxy in the vicinity of the solar system. The particles detected correspond to primaries with energies of the order of 30 GeV. Their radius of gyration in a galactic field of 3 μG would be less than 10^{-4} parsec, which implies a tight confinement within the galactic disk. A model of the galactic field with the main component directed along the spiral arms and a weaker dipole field perpendicular to the disk, would lead to an expected anisotropy in the cosmic-ray flux, with higher intensity in the direction of the local arm and, perhaps, in the direction of the galactic pole. The

observed pattern agrees with this model, and it also suggests that the magnetic tail of the Earth might play an important role in cancelling or enhancing the effects of galactic fields at different times of the year. (Diss. Abstr. Int., B)

5217 GALACTIC ANTIPROTON COSMIC RADIATION. Suh, Paul K. (Grumman Aerospace Corp., Bethpage, N. Y.). Astron. Astrophys.; 15: No. 2, 206-15(Dec 1971).

The energy spectrum for the cosmic antiproton flux in the galactic interstellar space was examined. The antiproton flux exhibited a peak around one BeV of antiproton energy, where the maximum flux lies in the proximity of 0.1 to 0.2% of the cosmic proton flux at the same energy. (auth)

5218 PRIMARY SPECTRUM OF COSMIC-RAY MODULATION ACCORDING TO OBSERVATIONS OF LATITUDE EFFECTS IN 1954–1962. Dorman, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 275-6(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 330-1(1971).

The energy spectrum of the 11-year cosmic-ray variation was found from observations of the latitude effects of the neutron and hard components at the solar-activity minimum and maximum. The spectrum was investigated in different solar-activity periods to understand the nature of the solar-wind effect on galactic cosmic rays. The modulation spectra were found by a method using coupling and integral particle production multiplicity coefficients that exclude errors introduced by global network data. The results from the Japanese measurements of the latitude effects of the neutron component on the vessels Labrador, Atka, Arneb, and Soya in 1954 to 1962 were used. (J.C.W.)

5219 INTRODUCTION OF CORRECTIONS FOR GLOBAL COSMIC-RAY VARIATIONS INTO DATA OF LATITUDINAL EXPEDITIONS. Blokh, Ya. L.; Dorman, L. I.; Kaminer, N. S.; Pimenov, I. A.; Rodionov, A. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 172-5(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 207-10(1971).

A method is proposed for analyzing the results of cosmic-ray measurements on expeditions, which permits introducing corrections for the variations of the primary component using a computer. (auth)

5220 INVESTIGATION OF THE NUCLEAR COMPONENT OF PRIMARY COSMIC RADIATION ON THE COSMOS-163 SATELLITE. Bredov, M. M.; Kolchin, A. A.; Lebedev, V. V.; Skrebtsov, G. P. (Ioffe Inst. of Physics and Tech., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 265-6(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 320-1(1971).

Cosmos-163 satellite was launched in June 1967 to investigate the nuclear component of primary cosmic radiation in the range $Z \geq 6$. A description is given of the equipment to make the investigation for reliable separation of definite groups of nuclei in the range of rigidities $R > 3.0$ GV. Fluxes of nuclei were determined and the spectra were shown. The slope of the spectrum agrees well with the Ogo-1 measurements of C and O nuclei, and the fluxes of nuclei did not change noticeably with solar activity in the period 1965 to 1967. A modulation had been noted between 1959 and 1964. (J.C.W.)

5221 TIME VARIATIONS IN HIGH-ENERGY COSMIC RAYS. Weeks, T. C. (Dublin Inst. for Advanced Studies, Ireland). Nature (London) Phys. Sci.; 233: No. 42, 129-30(18 Oct 1971).

Reference is made to Grewing and Heintzmann (Astrophys. Lett., 8: 167(1971)) who proposed a detailed model for the Crab Nebula pulsar predicting a cosmic-ray injection rate of 10^{36} particles/sec, with energies of 10^{14} eV per particle, and they suggested that this periodic flux might be detectable if the magnetic field configuration along the line of sight to the pulsar was favorable. The present author considers the conditions under which this would be possible, and also considers that a detailed study of the times of arrival of high-energy cosmic rays is warranted. If the magnetic field between the Earth and the pulsar were frozen in time, cosmic rays of the same energy from the pulsar would exhibit their fundamental injection rate when they eventually reached the Earth, and for a particular direction this would be the pulsar period. In practice these magnetic fields are variable, but it was felt worthwhile to consider the constraints on these variations that would make a periodic flux detectable. Detection of nonrandom fluctuations in cosmic-ray arrival times would be important in the understanding of cosmic-ray scattering, and if a characteristic pulsar period could be detected, this would be an important verification of the pulsar origin of cosmic rays. (UK)

5222 ORIGIN OF COSMIC ELECTRONS FROM ABOUT 10^2 TO 10^6 GeV. Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.); Lingenfelter, R. E. Phys. Rev. Lett.; 27: No. 19, 1309-12(8 Nov 1971).

The origin of high-energy cosmic electrons is considered. It is found that electrons of energies $\lesssim 10^3$ GeV could have been produced by local supernovae associated with known radio remnants. At higher energies, observations of muon-poor air showers indicate the existence of electrons at 10^6 GeV, which may have originated entirely from the supernova Vela X. (auth)

5223 COSMIC-RAY DECREASES AND THE OCCURRENCE OF SOLAR FLARES. Ballif, J. R.; Jones, D. E.; Skousen, E. N.; Smith, D. T. (Brigham Young Univ., Provo, Utah). J. Geophys. Res.; 76: No. 34, 8401-8(1 Dec 1971).

Mechanisms proposed to account for observed relationships between the occurrence of solar flares and cosmic-ray decreases at the Earth are examined by using a large fraction of all existing standardized flare data obtained from a continuously monitored Sun. The interval studied extends from July 1957 through July 1968. A total of 76 cosmic-ray decreases were identified during this interval. By using epoch analysis as well as inspection of the original data, it was found that active flare-producing regions crossed the central meridian just before the cosmic-ray decreases began. It was also found that a broad maximum in class 2 or greater flares occurred just before the decreases occurred. However, the flares forming this maximum were observed on the eastern part of the solar disk. Epoch analysis of decreases with greater amplitude shows the same relationships to the occurrence of flares. Even the most intense decreases that were thought to be the result of specific known flares show a direct relationship to the time of central-meridian passage of active flare-producing regions. It is concluded that the hypothesis that all large transient cosmic-ray decreases can be accounted for by interplanetary structure associated with active flare-producing regions is consistent with the data. Further, it is found that, if such flare-producing regions are the site of class 2 or greater flares as they approach meridian, the likelihood of a decrease at the Earth is slightly increased. (auth)

5224 COSMIC RAYS IN THE GALAXY: CONVECTION OR DIFFUSION. Skilling, John (Princeton Univ., N. J.). Astrophys. J.; 170: No. 2, 265-73(1 Dec 1971).

The theory of the self-trapping of cosmic rays in our Galaxy shows that cosmic-ray particles stream steadily away from their sources at a speed given by that of hydromagnetic waves. Random diffusion along magnetic field lines is a comparatively negligible process. A crucial role in confining high-energy cosmic rays is played by the less dense material on the edges of the galactic disk or in the halo. (auth)

5225 EXTRAGALACTIC COSMIC RAYS: A REAPPRAISAL. Burbidge, G.; Brecher, K. Comments Astrophys. Space Phys.; 3: No. 5, 140-8(Sep-Oct 1971).

The extragalactic theory of the origin of cosmic rays has been continuously attacked by Ginzburg and Syrovatskii, and their arguments against this hypothesis have been repeated quite uncritically by others. The authors feel that many of the objections to this theory are unjustified, and the present situation is discussed in light of this feeling. (W.D.M.)

5226 COSMIC RAYS OF ULTRA-HIGH ENERGY. Syrovatskii, S. I. (Lebedev Physical Inst., Moscow). Comments Astrophys. Space Phys.; 3: No. 5, 155-62(Sep-Oct 1971).

Arguments against the extragalactic origin of ultrahigh-energy cosmic particles are presented. A model is proposed in which pulsars provide not only the needed total power for galactic cosmic rays, but also sufficient energy for ultrahigh individual particles. (W.D.M.)

5227 PRIMARY COSMIC RADIATION. Catala de Alemany, J. (Univ., Valencia). Energ. Nucl. (Madrid); 15: No. 71, 209-23 13(May-Jun 1971). (In Spanish).

The history and nature of cosmic radiation is briefly reviewed. The interaction of cosmic radiation with matter (atmosphere and interstellar space), interaction of cosmic particles with magnetic fields, methods of detection, and mass and energy spectra are studied. From these data the age and origin of the cosmic primaries are determined, according to the different existing theories. It is concluded that the origin of cosmic radiation is still unknown. (tr-auth)

Direct Energy Conversion

Refer also to abstract 5241.

5228 (N-71-33739) EMPIRICAL FORMULATION OF THERMIONIC CONVERTER PERFORMANCE AS A FUNCTION OF ELECTRODE EMISSION PROPERTIES. Smith, John R.;

Smith, Arthur L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug 1971. 16p. (NASA-TM-X-2358). NTIS.

A simple empirical equation giving the emission current density in terms of the cesium atom arrival rate and the electrode surface temperature is presented. The Swanson–Strayer correlation for the maximum change in work function due to cesium adsorption is compared with field-emission data for some refractory metals. Oxygen effects are discussed. (auth) (STAR)

5229 (N-71-34048) CORRELATION EXPRESSION FOR THE PERFORMANCE OF AN ETCHED-RHENIUM EMITTER, NIOBIUM COLLECTOR, CESIATED THERMIONIC CONVERTER. Breitwieser, Roland (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1971. 5p. (NASA-TM-X-2380). NTIS.

An equation is presented that correlates current, voltage, emitter temperature, and collector temperature of a cesiated thermionic converter using an etched-rhenium emitter and a niobium collector. (auth) (STAR)

5230 DETERMINING THE CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC GENERATOR OPERATING ON NONEQUILIBRIUM PLASMA. Biberman, L. M.; Vorob'ev, V. S.; Kovbasyuk, V. I.; (and others) (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 132-6 (Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 159-64(Jan-Feb 1971).

In recent years the possibility of creating industrial closed-cycle electric power stations with magnetohydrodynamic generators has been discussed extensively. Such a combination imposes specific requirement on the MHD generator. The parameters and characteristics of a closed-cycle MHD generator with nonequilibrium plasma in its channel are determined. (auth)

5231 CONCERNING THE OPTIMIZATION OF THE PARAMETERS OF A CLOSED-CYCLE MHD GENERATOR CHANNEL. Vorob'ev, V. S.; Krasnov, V. I. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 137-41(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 165-9(Jan-Feb 1971).

The local internal efficiency of the channel of the MHD generator (η_0) is optimized relative to the admixture fraction (Δ), the Mach number (M), the electron temperature for a stipulated conductivity level, the magnetic field induction, the deceleration parameters of the flow, and the flow composition. The problem of the conditional extremum is reduced to the solution of a system of two algebraic equations which depend on two parameters representing a combination of the original quantities for a given type of admixture. Graphs were given which allow the optimal values of Δ, M, and T_e to be chosen so as to ensure the maximum η_0 over a wide range of conditions for various admixtures and inert gases. (auth)

5232 THERMAL SCHEMES OF CLOSED-CYCLE ELECTRIC POWER PLANTS WITH A NONEQUILIBRIUM MHD GENERATOR. Shumyatskii, B. Ya.; Kovbasyuk, V. I.; Rogachev, A. P.; Stolyar, L. P. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 142-5(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 170-3(Jan-Feb 1971).

An examination was made of possible variants of a thermal scheme of an industrial closed-cycle electric power plant with a nonequilibrium MHD generator and compressor drive from an electric motor, gas turbine, or steam turbine. (auth)

5233 SELECTION OF A SYSTEM OF DIMENSIONLESS NUMBERS FOR GENERALIZING THE VOLT-AMPERE CHARACTERISTICS OF THERMIONIC CONVERTERS. Kharitonov, V. V. (Gomel State Univ., USSR). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 150-3(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 178-81 (Jan-Feb 1971).

From an examination of processes occurring in thermionic heat converters the author introduces electrodynamic analogs of Nusselt, Stanton, Prandtl, and Peclet numbers on the basis of the existence of a physical analogy between processes of heat, mass, and momentum transfer and processes of electron transfer in the interelectrode space. It is shown that the use of the proposed dimensionless numbers permits representing processes in the converter in the form of generalized volt–ampere characteristics of the dimensionless equation type. A comparison showed good agreement of the theoretical and experimental data. (auth)

5234 EXPERIMENTS ON MHD POWER GENERATION WITH A SUPERCONDUCTING MAGNET. Fushimi, Kozo; Todoriki, Itaru; Ushio, Kazuhiro; (and others). Denki Shikensho Iho; 35: No. 5, 513-17(1971). (In Japanese).

A dewar with the room-temperature bore was tested for an MHD power generator. The evaporating rate of liquid helium from the dewar with the magnet is 12 l/h. Preliminary experiments on the burner of the MHD power generator were also performed. Then, experiments were conducted on the MHD power generation by using a saddle-shaped superconducting magnet cooled down by a refrigerator, and a power output of a few tens of watts was obtained. As for the experimental conditions, the central magnetic field of the magnet is 22 kG for 400 A of coil current and the working fluid of the MHD generator is the combustion product of C_3H_8, O_2, and CH_3OH + KOH. The mass flow rate and electric conductivity of the combustion gas are 140 g/sec and 9.2 ℧/m, respectively. Results obtained about MHD power generation using a superconducting magnet are briefly discussed. (auth) (Japan)

5235 THERMOELECTRIC MATERIALS, 1970. Sittig, Marshall. Chemical Process Reviews. Park Ridge, N. J.; Noyes Data Corporation (1970). 250p. $35.00.

Techniques for producing thermoelectric materials are presented, based on the U. S. Patent literature since 1960. The Table of Contents serves as a subject index. Inventor, patent number, and company indexes are provided. (M.H.R.)

5236 DESIGN AND CONSTRUCTION OF ELECTRIC POWER PLANTS WITH MAGNETOHYDRODYNAMIC GENERATORS. Kugushev, N. M.; Zlatin, D. A.; Petrov, Yu. A.; Makin, S. A. Tr. Vses. Proekt. Inst. Teploelektroproyekt; No. 9, 95-110(1970). (In Russian).

A brief exposition is given of the characteristics of practical utilization of the MHD method of energy conversion. Possible technological diagrams of electric power plants with MHD generators are described, as well as methods for further developments along these lines. Consideration is given to the planning of new nonstandard equipment, a brief description of the characteristics of systems for control, automation and protection of equipment, as well as basic solutions for putting together the main building. (JPRS)

Fluid Physics

Refer also to abstracts 5334 and 5431.

5237 (EUR-CEA-FC-604) MHD EQUILIBRIUM CHARACTERISTICS. Bouligand, G. M. (Commissariat a l'Energie, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).

The Cauchy problem is considered for the case of MHD equilibria: equilibria are sought from the known values of the pressure and the magnetic field components at every point in any given surface S. The problem was not explicitly solved, the first partial derivatives of the field and pressure being determined for every point in S. (France)

5238 MAGNETOHYDRODYNAMICS OF CONICAL FLOWS. Narain, Jai Prakash; Uberoi, Mahinder S. (Univ. of Colorado, Boulder). Phys. Fluids; 14: No. 12, 2687-92(Dec 1971).

The effect of diverging or converging electric currents on a stationary, viscous, incompressible, conducting body of fluid, confined in a cone of infinite extent, is investigated. The fluid moves down from upstream infinity near the walls and as it approaches the apex of the cone, it changes its direction in the core of the cone and moves toward upstream infinity near the axis. With increasing currents, the velocity near the axis rises very rapidly. Similar phenomena were observed in the laboratory electric arcs and in thermal plasmas of the solar atmosphere. Next, when a fixed amount of fluid is drained from the apex of the cone, the flow divides into two regions far from the apex. The drained fluid reaches the apex only through a narrow region near the walls, whereas fluid in the core of the cone executes a secondary motion similar to the first case of confined flow. There exists a stagnation point on the axis, and its location is primarily controlled by current density, fluid drainage rate, and the cone angle of the configuration. (auth)

5239 LINE SINK IN UNIFORM MAGNETIC FIELD. Narain, Jai Prakash; Uberoi, Mahinder S. (Univ. of Colorado, Boulder). Phys. Fluids; 14: No. 12, 2693-6(Dec 1971).

The motion of an inviscid, incompressible, and conducting fluid due to a line sink in a uniform strong magnetic field is considered. The solutions show that motion is confined in a narrow region parallel to the magnetic field. Such a motion for a point sink has er-

roneously been named as a wake or backward jet flow. Finally, the known solution of a point sink in uniform magnetic field is extended to apply nearer the sink than the original solution. (auth)

5240 EFFECTS OF AN EXTERNAL CIRCUIT ON THE DISPERSION OF SOLUBLE MATTER IN A MAGNETOHYDRODYNAMIC CHANNEL FLOW. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay). Phys. Fluids; 14: No. 12, 2776-8 (Dec 1971).

The effective Taylor diffusion coefficient, D*, decreases more rapidly with increasing Hartmann number, M, in a short-circuited channel flow as compared with an open-circuited case. In the generator, D* is almost negligible for M > 20. In an accelerator, an increase in V_g^* leads to an increase in D*. (auth)

5241 POSSIBILITY OF USING MICROWAVE IONIZATION FOR OBTAINING NONEQUILIBRIUM PLASMA IN MHD GENERATORS. Usikov, A. Ya.; Truten, I. D.; Motornenko, A. P.; Belousov, E. V. (Inst. of Radio Physics and Electronics, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 705-10(May 1971). (In Russian).

Estimated calculations are presented for efficiency of using such a preionizer in MHD devices. The data obtained are compared with results of experiments on using electron flow as a preionizer in MHD generators. (auth)

5242 STUDY OF A TWO-PHASE MEDIUM IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kartsev, V. A.; Sviklis, B. B. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 57-60(1971). (In Russian).

Analytic dependences describing the hydrodynamics of a two-phase medium in a plane channel with nonconductive walls in crossed electric and magnetic fields are obtained, based on a model of interpenetrating fluids. The motion of the media is assumed to be laminar and stabilized, the two-phase medium being a conducting fluid with a nonconducting dispersed phase. (auth)

5243 RESISTANCE TO FLOW OF AN ELECTROCONDUCTING LIQUID IN PLANE INSULATED DUCTS IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD ALLOWING FOR THE END EFFECT AND ROUGHNESS OF THE WALLS. Bocheninskii, V. P.; Branover, G. G.; Tananaev, A. V.; Chernyaev, Yu. P. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 4, 10-21(Jul-Aug 1971). (In Russian).

Pressure and velocity distribution, and energy potentials were investigated in mercury flow in isolated ducts of rectangular cross sections with large side ratios (Hartmann type flow). Measurements included the following ranges of number parameters: Reynolds, $7 \times 10^3 \leq R \leq 5 \times 10^5$; Hartmann, $0 \leq H \leq 490$; and Stewart, $0 \leq N \leq 24$. The regions of entrance into and exit from the magnetic field were carefully examined; the pressure was nonuniform throughout the cross section, and the velocity profile in a plane perpendicular to the magnetic field acquired an M shape. A coefficient of resistance for a stabilizing flow was obtained in the magnetic field, and a correlation was secured for the Reynolds and Hartmann numbers. Flows in ducts of small side ratios ($a/b < 1/14$) were investigated as functions of a large number of variables. (K.S.W.)

5244 HYDRODYNAMIC INTERACTION OF PROFILED LATTICES IN A POTENTIAL FLOW. Saren, V. E. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 4, 75-84(Jul-Aug 1971). (In Russian).

The problem of an unbroken flow of a potential flow of an incompressible fluid through two mutually movable profile lattices was studied. Formulas were obtained which defined the circulation velocity of a fluid through the two lattices, where the first lattice was thick and curvilinear in section and the second was an uncommon assortment of plates. The coefficients of separation of the sought-for fluid velocities on the profile of each lattice lead to a solution of a finite number of linear integral equations for the contour of one of the lattice profiles. (K.S.W.)

5245 ENERGY ANALYSIS OF STABILITY OF MAGNETOHYDRODYNAMIC CURRENTS. Sagalakov, A. M.; Shtern, V. N. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 4, 3-9(Jul-Aug 1971). (In Russian).

An analog was formulated for Orr's problem of MHD currents. Random, three-dimensional perturbations were explored, which were satisfied by a continuity equation. The immediate interaction of the perturbations of the magnetic field and of the velocity field can not increase the power estimate from Reynolds number. At small magnetic Reynolds numbers calculations were made for a Hartmann flow and for modified Couette flows. Minimum values of R were achieved at perturbations with a wave vector perpendicular to the velocity vector of the basic flow. (K.S.W.)

5246 VORTICITY JUMP CONDITIONS ACROSS MAGNETOGASDYNAMIC DISCONTINUITIES IN AN UNSTEADY FLOW. Singh, Bijai; Ram, Rishi (Banaras Hindu Univ., India). Tensor; 22: No. 3, 345-50(Sep 1971).

The results of earlier studies are generalized for unsteady MHD flows. The results show that in the presence of a magnetic field oblique to the direction of propagation of the discontinuity, the derivation of the vorticity jump condition is not possible from the momentum equation alone. It is also shown that, in some particular cases of the acting magnetic field, it is possible to obtain the vorticity jump conditions without using the thermodynamic properties of the fluid. (M.O.W.)

5247 CURRENT LINES GENERATED BY A SWITCHOFF HYDROMAGNETIC SHOCK IN AN UNSTEADY FLOW. Sharma, V. D.; Ram, Rishi (Banaras Hindu Univ., India). Tensor; 22: No. 3, 363-8(Sep 1971).

The hypothesis is given and theorems are proven for determining the current density and curvature of current lines. (M.O.W.)

5248 LAMINAR FLOW IN CIRCULAR PIPES UNDER THE EFFECT OF A TRAVELING MAGNETIC FIELD. Fawzi, T. H.; Burke, P. E. (Univ. of Toronto). Phys. Fluids; 14: No. 12, 2680-7(Dec 1971).

The interaction between the flow of a conducting incompressible fluid in an infinitely extended circular pipe and the magnetic field created by an azimuthal traveling wave current sheet surrounding the pipe is studied. Only low magnetic Reynolds number flows are considered. Exact solutions for the magnetic-field distribution are obtained. Closed form solutions for the laminar velocity profile are developed. The latter are used to examine the effect of the magnetic field on the friction coefficient and total energy balance. The solutions show that, for positive pressure gradients and strong magnetic fields, secondary flows appear. These flows have previously been observed experimentally. The solutions also show that the stabilizing effect of the magnetic field in general, depends on an equivalent Hartmann number—which is a function of the wavelength of the traveling wave—and on the difference between the wave velocity and the average fluid velocity. (auth)

Upper Atmosphere Physics

5249 (LA-DC-12711) SUBSTORM BEHAVIOR OF PLASMA SHEET PARTICLES. Hones, Edward W. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 26p. Dep. NTIS.

The general features of plasma-sheet substorm behavior established from Vela-satellite data are described. A feature of the magnetotail behavior during a substorm is the thinning and subsequent thickening or recovery of the plasma sheet. It has been suggested that the thinning of the plasma sheet resulted from displacement of magnetotail plasma toward the Earth, possibly in consequence of enhanced merging of interplanetary and magnetospheric magnetic fields and buildup of the tail magnetic-field intensity. The subsequent thickening of the plasma sheet might then result when magnetic field merging across the neutral sheet in the tail starts, allowing stretched-out field lines to contract rapidly Earthward. Observational data now support these features: (a) magnetic field erosion from the front of the magnetosphere before the expansive phase of a substorm, (b) buildup of tail magnetic field strength early in substorms, (c) magnetic field-line contraction or collapse toward the Earth during the expansive phase of substorms, and (d) movement of the inner edge of the plasma sheet toward the Earth during substorms. (J.C.W.)

5250 (N-71-28508) ELECTRON HEATING PROCESSES IN THE MIDDLE IONOSPHERE. Chang, Tieh Chun (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug 1970. 106p. (NASA-CR-119031). NTIS.

Thesis.

The equilibrium distribution functions for electrons in the ionospheric plasma were calculated for the energy interval of 0 to 15 eV, utilizing data collected in a pulse-probe experiment. By using the densities and characteristic temperatures of superthermal and thermal electrons, the electron heat input rates were calculated to be between $3 \times 1{,}000$ and $1.5 \times 10{,}000$ eV/cm^3 sec in the altitude range between approximately 120 and 240 km. The correlation between the electron heat input rates and the heat-loss rates in this altitude range has been studied. The equilibrium energy distributions of the secondary electrons in the middle ionosphere by solar ionizing radiation were calculated for electrons with energies less than 15 eV. A high-energy electron distribution (E > or = 15 eV) contributes the retarded-probe current that appears to be a linear function of the retarding-probe potential. (auth) (STAR)

5251 (N-71-29709) GENERAL FORMULA FOR THE DECAY LIFETIMES OF THE STARFISH ELECTRONS. Stassinopoulos, E. G.; Verzarin, P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jul 1971. 14p. (NASA-TN-D-6284). NTIS.

A treatment based on the analysis of data from Satellite 1963 38C was developed to calculate the decay lifetimes of the artificial electrons produced by the Starfish nuclear explosion. The treatment makes use of experimental data and describes the decay lifetime τ in the form of a continuum in BLE-space. The results are valid over the entire inner zone of the trapped radiation belt. Reference maps of constant τ contours in BL-, BE-, and LE-space were constructed and are discussed. (auth) (STAR)

5252 (N-71-29923) UNIPOLAR INTERACTION OF MERCURY WITH THE SOLAR WIND: THE STEADY-STATE BOW SHOCK PROBLEM. Colburn, D. S.; Sonett, C. P.; Schwartz, K. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Jul 1971. 40p. (NASA-TM-X-62028). NTIS.

The steady-state electromagnetic interaction of the solar wind with the planet Mercury is computed for a spectrum of electric conductivity functions using the assumption that no atmosphere or magnetic field damps the direct interaction. The form of the induction is described by the unipolar effect and corresponds to the zero-frequency limit of a transverse magnetic mode. Calculations are included to determine the effective surface temperature of the planet. These calculations include the apparent motion of the Sun in the Hermean sky. It is shown that a significant interaction, detectable by a space probe, is plausible for reasonable conductivity functions. The strength of the interaction is considered in terms of the subsurface thermal gradient, and computations are given relating the strength of the solar-wind interaction with the conductivity parameters. (auth) (STAR)

5253 (N-71-30094) ELECTRIC FIELDS IN THE IONOSPHERE AND MAGNETOSPHERE. Maynard, Nelson C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jun 1971. 42p. (NASA-TM-X-65596). NTIS.

Techniques for measuring ionospheric and magnetospheric electric fields and existing measurements are reviewed. Considerable progress in understanding electric fields was made in the auroral regions where fields originating basically from convection patterns in the magnetosphere and modified by ionospheric interaction were detected by both the barium-ion cloud and double-floating-probe techniques and compared with predictions. The anticorrelation of electric fields and auroral arcs, the establishment of the auroral electrojet currents as Hall currents, the irregular nature of the electric fields, and the reversal of the electric fields between the eastward and westward electrojet regions are included. Convection across the polar cap is anti-Sunward. Measurements of dc electric fields at lower latitudes are much more sparse and show agreement and disagreement with Sq-dynamo electric-field predictions. Variational effects in the electric fields were found wherever strong fields exist. Both electrostatic and electromagnetic phenomena were detected looking at the ac components. (auth) (STAR)

5254 (N-71-30139) ANALYSIS OF DATA ACQUIRED ON 1968 AIRBORNE AURORAL EXPEDITION. Final Report, 1 August 1968-30 June 1970. Romick, Gerald J. (Alaska Univ., College. Geophysical Inst.). 1970. 50p. (NASA-CR-119185). NTIS.

The analysis of data from both the 1968 and 1969 NASA Airborne Expeditions covers general areas of spectral variability of both aurora and airglow emissions in a wide range of latitudes and longitudes. It is found that: (1) the ratio $\lambda 4278/\lambda 5577$ of N_2^+ seems to be constant across at least one discrete auroral form, (2) the ratio $\lambda 5001/\lambda 5006$ of N-II emissions appears to be due to direct dissociation ionization and excitation of N_2, and (3) the mid-day sector of the auroral oval and polar cap shows zones of electron precipitation (as deduced from the $\lambda 6300/\lambda 4278$ ratios with latitude). (auth) (STAR)

5255 (N-71-30260) P' (f) TO N(h) INVERSION PROBLEM IN IONOSPHERIC SOUNDINGS. Jackson, John E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1971. 45p. (NASA-TM-X-65591). NTIS.

Inversion techniques used to derive the ionospheric electron density N as a function of altitude h from group path P' vs frequency f measurements obtained by vertical incidence ionospheric sounders are reviewed. The medium under investigation, the experimental techniques used to obtain the P'(f) data, the theoretical considerations that lead to the integral equation relating P'(f) to N(h), and the assumptions made in the inversion process are discussed. The lamination inversion technique is then presented, with special attention given to mathematical difficulties arising from discontinuities in the P'(f) function, infinites in the integrand, and in some cases unknown integration limits. Methods are outlined for minimizing the uncertainties due to discontinuities. (auth) (STAR)

5256 (N-71-30261) ROTATIONAL DISCONTINUITIES IN THE SOLAR WIND. Turner, James Marshall (Massachusetts Inst. of Tech., Cambridge). May 1971. 32p. (NASA-CR-119172; CSR-P-71-60). NTIS.

Solar-wind plasma and magnetic-field data from Mariner 5 are used to identify rotational discontinuities. Of the 40 discontinuities found, 36 were clustered in three distinct three-to-six-day intervals and were characterized by high solar-wind bulk velocities, high magnetic-field magnitudes, low densities, and high correlation between velocity and magnetic-field changes. Strong evidence that smooth Alfvén waves were also present during these times was obtained. The rotational discontinuities, which are sharp-crested Alfvén waves, had planes of polarization generally 10 to 20° away from the planes of polarization of the smooth Alfvén waves. An examination of the qualitative features of fast plasma streams and slow plasma streams revealed several striking differences in the behavior of the magnetic field and velocity and their fluctuations, the field magnitude, and the density. It is suggested that these differences are significantly correlated with the occurrence of rotational discontinuities. (auth) (STAR)

5257 (N-71-30613) EXPECTED ELECTRON AND PROTON ENVIRONMENT FOR THE COSMIC X-RAY EXPERIMENT ABOARD THE OSO-1 AND OSO-H SATELLITES. Stassinopoulos, E. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jul 1971. 23p. (NASA-TM-X-65624; X-641-71-293). NTIS.

A study was conducted to determine the ambient trapped-particle fluxes encountered by OSO I, to evaluate the contamination of the cosmic x-ray detectors during times of apparently normal data acquisition and to develop means for rejection of background events and/or provide a suitable normalization monitor. The study was expanded to provide data for the determination of possible radiation damage to COS/MOS devices on OSO I and H. Orbital flux integrations for high-energy electrons and protons were calculated using Vette AE2 (electron) AP1, AP6, and AP7 current models. The spectral distribution of both types of particles are presented. (auth) (STAR)

5258 (N-71-30849) EARTH'S IONOSPHERE: SPACE DESIGN CRITERIA (ENVIRONMENT). Lyle, R. G.; Stabekis, P. D. (Exotech, Inc., Washington, D. C.). Mar 1971. 49p. (NASA-SP-8049). NTIS.

The characteristics of the Earth's ionosphere that must be taken into account in space-vehicle design are detailed. They include electron density and temperature, the neutral component, ionic composition, and plasma temperature. In addition, derived functions are given that are useful for analyzing the interaction of the spacecraft and ionospheric medium. (auth) (STAR)

5259 (N-71-30896) REDUCTION AND ANALYSIS OF TWO SETS OF ELECTRON CONTENT MEASUREMENTS PERMITTING THE INFERENCE OF ELECTRON DENSITY IN THE SOLAR WIND. Final Report. Croft, T. A. (Stanford Univ., Calif. Radioscience Lab.). Jun 1971. Contract NAS2-4672. 40p. (NASA-CR-114356). NTIS.

Measurements of the electron content from Earth to several sun-orbiting and geostationary Earth satellites were obtained by radio propagation means at various times in various sequences spread continuously over a period of 5.3 years. Through processing and analysis it is possible to infer the electron content of the solar wind along the radio path above the orbit of the geostationary craft, effectively removing the influence of the Earth's ionosphere and magnetosphere from the derived result. Dividing the interplanetary content by the spacecraft distance yields the average free electron number density of the solar wind along the radio path. The density thus observed is of great potential scientific value, both in the study of short unusual events and in the derivation of long-term statistical properties of the wind. (auth) (STAR)

5260 (N-71-33392) VLF HISS AND RELATED PLASMA OBSERVATIONS IN THE POLAR MAGNETOSPHERE. Progress Report, May 1971. Gurnett, Donald A.; Frank, Louis A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Contracts NAS5-10625; NAS1-8141; NAS1-8144(f). 59p. (NASA-CR-121418). NTIS.

Auroral-zone vlf hiss and low-energy charged-particle observations with the Injun-5 satellite are presented. The results provide the first direct verification of the association between auroral-

zone vlf hiss and intense fluxes, 10,000 to 10^{-7} electrons (sq cm-sec-sr-eV), of low-energy electrons with energies on the order of 100 eV to several keV. On the dayside of the magnetosphere, these low-energy electrons are identified with the dayside polar-cusp region. At other local times, the vlf hiss and low-energy electron-precipitation regions are believed to correspond to the extension of the dayside polar cusp into the distant plasma sheet and downstream magnetosheath on the nightside of the magnetosphere. On the basis of present models, the observed vlf-hiss intensities cannot be accounted for by incoherent Čerenkov radiation from the observed electron fluxes, indicating that a coherent plasma instability mechanism is involved in some, if not all, of the vlf-hiss generation. (auth) (STAR)

5261 (N-71-34298) FIELD LINE MOTION DURING GEOMAGNETIC STORMS. Konradi, Andrei; Horng, Jiann-Tsorng; Kaufmann, Richard L. (National Aeronautics and Space Administration, Houston, Tex. Manned Spacecraft Center). 1971. 57p. (NASA-TM-X-67295). NTIS.

It was found during two intense substorms that the high-latitude trapping boundary for 20-keV electrons and 100-keV protons becomes very thin in the early morning hours. The gradients are too steep to be maintained by drifting particles, so they must be produced locally over the night side of the Earth. The flux gradient is seen to move at speeds in excess of 100 km/sec. Plasma appears to move away from the tail and around the Earth at these high speeds during the sudden expansion phases of the substorms. The rapid plasma motion requires the presence of 50 to 100 mV/m electric fields at a geomagnetic latitude of 30 deg on the L = 5 field line. The observations fit best into a model that contains two field-aligned sheet currents. Current flows downwards toward the ionosphere at or beyond the poleward edge of the disturbance, and away from the Earth at lower latitudes. (auth) (STAR)

5262 (N-71-34299) ELF NOISE BANDS ASSOCIATED WITH AURORAL ARCS. Gurnett, D. A.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1971. Contracts NAS5-10625; NAS1-8141; NAS1-8144; NAS1-8150. 20p. (NASA-CR-121676). NTIS.

Observations of a type of elf-noise band closely associated with low-energy electron-precipitation events and auroral arcs are reported. The observations were made at relatively low altitudes (<3000 km) with the polar-orbiting satellite Injun 5. The noise bands typically have a center frequency of from 100 to 300 Hz and often appear to consist of many nearly-monochromatic bursts, typically of a few seconds duration, superimposed to give the observed spectrum of the emission. These elf-noise bands were only observed in a relatively narrow latitudinal region in the auroral zone. It is noted that the spectral characteristics of this noise are very similar to a type of narrow-band magnetic noise called lion's roar which was observed at much higher altitudes in the magnetosheath with the satellite OGO 5. It is suggested that the elf noise bands observed are produced by lion's roar emissions that have propagated down open magnetic-field lines from the magnetosheath region to the Injun-5 altitude. (auth) (STAR)

5263 (N-71-34300) CORRELATED SATELLITE MEASUREMENTS OF LOW-ENERGY ELECTRON PRECIPITATION AND GROUND BASED OBSERVATIONS OF A VISIBLE AURORAL ARC. Ackerson, K. L.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1971. Contract NAS5-10625. 28p. (NASA-CR-121675). NTIS.

A comparison of low-energy charged-particle intensities measured with the low-altitude satellite Injun 5 and a ground-based observation of an auroral arc at Fort Churchill on Dec. 21, 1968 during late local evening established that an intense precipitation band of electron intensities provides the primary energy influx for the auroral light. This precipitation event was located poleward of and adjacent to the trapping boundary for more energetic electron intensities. The peak energy fluxes were directed along the local magnetic-field direction into the Earth's atmosphere. Proton and electron intensities similar to those in the plasma sheet in the magnetotail were observed in a substantially less-intense zone positioned equatorward of and adjacent to the trapping boundary. Angular distributions of these particle intensities from the plasma sheet were peaked at pitch angles perpendicular to the local magnetic field. (auth) (STAR)

5264 (N-71-34903) ELECTRON WAVE INSTABILITIES IN A MAGNETOPLASMA CAUSED BY ELECTRON–NEUTRAL COLLISIONS. Howell, John Q. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Sep 1971. 113p. (NASA-TR-R-363; L-7531). NTIS.

A new class of collision-dependent electron waves is found in a non-Maxwellian Lorentz magnetoplasma, and it is shown that electron–neutral collisions may cause these waves to become unstable. The Boltzmann equation with collision integral is solved while assuming propagation to be either parallel or perpendicular to the magnetic field. Both conductivity tensors are derived and put in a form that is useful for numerical calculations. The full set of Maxwell's equations is then used to derive the dispersion relations for both directions of propagation. The dispersion relations are initially solved for a monoenergetic electron distribution function, and then an isotropic distribution with a peak of nonzero half-width is treated. Some consideration is also given to an isotropic Maxwellian distribution, both with and without a bump on the tail. As an example of propagation parallel to the magnetic field, transverse electromagnetic or whistler waves in a nitrogen plasma are considered. A new collisional mode is found with real frequency near the electron-cyclotron frequency, and under appropriate conditions it may be either convectively or absolutely unstable. Longitudinal or electrostatic waves propagating perpendicular to the magnetic field in a nitrogen plasma are also considered. A series of new collisional modes with real frequency near the electron frequency and its harmonics are shown to be unstable under some conditions. For both directions of propagation, the electron waves can be unstable if a large fraction of plasma electrons have their velocity in a region where the electron–neutral collision frequency increases (or decreases) rapidly enough. The requirement on the electron–neutral collision frequency is easily met by nitrogen, mercury, and the Ramsauer gases. (auth) (STAR)

5265 SPHERICAL CONE IN THE SOLAR WIND THAT MODULATES COSMIC RAYS. Belov, A. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 273-4(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 328-9(1971).

A condition is studied when the solar plasma has special properties in a spherical sector centered above the Sun at a certain aperture. The conditions for charged-particle propagation in the solar wind above action regions of the Sun are long-lived and produce asymmetric flux of magnetic inhomogeneities and, as a consequence, give rise to quasi-periodic cosmic-ray variations of the 27-day type. The cosmic-ray density distribution within the modulating cone and the modulation intensity are determined. The boundary conditions and the quantities that determine the modulation intensity are expressed and finally shown is the dependence of the amplitude of the quasi-periodic variation on the scales of asymmetry, on the difference in the conditions for diffusion-convection inside and outside the cone, and also on the modulation intensity by the entire solar wind. (J.C.W.)

5266 MAGNETIC SCATTERING OF CHARGED PARTICLES ON CYCLOTRON INSTABILITY WAVES OF RADIATION-BELT PLASMA. II. Il'in, V. D.; Beloshitskii, V. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 277-9(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 332-3(1971).

An analysis was made of the resonance scatter of protons on cyclotron-instability waves of radiation-belt plasma using expressions formerly determined for the coefficients of diffusion and relaxation time for electrons. Waves generated by particles of some energies effectively scatter particles of much greater energies because of strong geomagnetic-field inhomogeneity. An application is made using the relaxation time for protons during their scatter on quasi-monochromatic Pcl pulsations assuming that pearls or the Pcl pulsations are excited as a result of cyclotron instability. (J.C.W.)

5267 REPRODUCIBILITY OF ELECTRON DENSITY IN THE IONOSPHERIC F REGION. Velichanskii, V. N.; Krinberg, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 279-81(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 334-5(1971).

A qualitative characteristic of the random fluctuations of electron density in the ionosphere was obtained to study the random disordered variations. Electron density in the ionosphere is determined mainly by the composition of the neutral atmosphere and solar-radiation intensity. These vary with the time of day, seasons, solar activity level, and the distance to the Earth's surface. Data for electron densities for heights at 130 to 300 km and the time at 8 to 17 hr, measured by vertical soundings and one incoherent scatter experiment were used. Various sets of conditions were investigated. (J.C.W.)

5268 SMALL-SCALE INHOMOGENEITIES OF THE IONOSPHERIC F REGION. Perelygin, V. P. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 281-3(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 336-7(1971).

Small-scale irregularities in the F region and their motions were investigated by spaced reception during simultaneous radio-

astronomic observations and vertical sounding. Radio astronomic data were analyzed that referred to the passage of the radio source Cassiopeia-A, upper culmination, which provided for the relative equivalency of the observed regions. Vertical sounding measurements were made near critical frequencies on one of the magnetoionic components. Observational frequencies were chosen which provided for close agreement of measurements aloft. Vertical sounding data were obtained in the presence of moderate spread F. Various methods show that the character of the annual variations of horizontal drift is the same, but the drift velocity determined by the method of similarity is somewhat higher in radio-astronomic measurements than in ground-based ionospheric soundings. (J.C.W.)

5269 STATISTICAL E_s LAYER RELATIONSHIPS AT CONJUGATE POINTS. Tien, Chin Khong (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 285-6(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 339-41(1971).

The relationship between the probability of occurrence of various types of E_s at conjugate points is investigated by analyzing ionospheric parameters that were obtained during the equinoctial months. Data from Sogra, from an expedition station on the Dvina River, and from Keguelen are used. A correlation has been found in the appearance of E_s layers at conjugate points at polar and subpolar latitudes. Since the high-latitude E_s layer is associated with the injection of charged particles into the polar atmosphere, the conjugacy of E_s was explained by the symmetric spreading of the flux in both hemispheres. Computed particle energies and flux densities are shown for Sept. 8 and 23, 1966. It is seen that particle energies are almost the same in both hemispheres, while the flux densities fluctuate strongly. (J.C.W.)

5270 EQUATORIAL SPREAD F OVER THE ATLANTIC. Dolgova, E. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 287-8(1971).

Translated from Geomagn. Aeron.; 11, No. 2, 342-3(1971).

During the 1965–1966 Atlantic cruise of the schooner Zarya, equatorial spread F was observed every day in the region with an inclination $I \leq \pm 35°$. This agrees with the results where three zones of maximum frequency of spread F were determined for the American and Far East sectors, two between 50 and 80° geomagnetic latitude and one equatorial zone with $I \leq \pm 36$. The width of the equatorial spread F belt did not remain constant throughout the night. It has been demonstrated previously that equatorial spread F appears simultaneously with the rise of the F2 layer after sunset. There is information on the increase of equatorial spread F on magnetically quiet days compared with disturbed days. This effect of magnetic disturbances on equatorial scatter has not been established from the Zarya data, nor was the decrease in the evening growth of h_pF2 on disturbed days. The time when the F2 layer rose was only observed to shift slightly toward later evening hours on days with enhanced magnetic disturbance. (J.C.W.)

5271 APPLICABILITY OF THE "QUASI-DIPOLE" APPROXIMATION IN THE METHOD OF PARTIAL REFLECTIONS. Grishkevich, L. V.; Ivanov, V. A.; Fedoseeva, T. N. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 293-5 (1971).

Translated from Geomagn. Aeron.; 11: No. 2, 348-9(1971).

Two mathematical methods used to describe ionospheric characteristics were the piecewise-linear approximation and approximation by means of a quadratic polynomial. Relative sunspot number and the flux density of solar radio noise in the decimeter range are used for solar-activity indexes. Regression equations were computed to compare piecewise-linear, nonlinear, and linear with previous nonlinear transformation of the solar activity index for the noon, f_0F2 noon, and minimum, f_0F2 min, critical F2-layer frequencies at Tomsk over the 1954–1964 solar-activity cycle. Analogous conclusions were derived from an investigation of the mathematical description of f_0F2 variations at other hours of the day and also for various averaging levels. (J.C.W.)

5272 TEMPORAL CHARACTERISTICS OF THE EVENING IONIZATION MAXIMUM. Kolesnik, A. G.; Chernyshev, V. I. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 295-6(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 350-1(1971).

A controversy exists on the characteristics of the diurnal variation of critical F2-layer frequencies at middle latitudes having additional ionization maximum in the evening. It is believed by the authors that the most acceptable assumption of the appearance of the evening maximum is attributed to the sharp temperature drop in the evening. Two parameters investigated substantiate the results that the time difference between the f_0F2 maxima at noon and in the evening and the time between the two instants of the evening maximum, characterized by the beginning of growth of critical frequencies f_0F2_1 and their maximum value f_0F2_2, exist. Vertical sounding data made at Tomsk between 1960 and 1968 were used to conclude that the relationship obtained confirms the connection between the evening ionization maximum with the thermodynamic state of the atmosphere. (J.C.W.)

5273 DETERMINATION OF THE REACTION RATE COEFFICIENTS FROM THE VERTICAL ELECTRON DENSITY PROFILE. Velichanskii, B. N.; Klimov, N. N.; Krinberg, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 296-9(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 351-3(1971).

The numerical values of the reaction rate coefficients α and γ, needed to compute the ion production and loss rates in the Earth's ionosphere, are determined from laboratory experiments and from analyses of experimental data on the variation of electron density in the ionosphere. The accepted method using the experimental data is obtained between the experimental $n^*(t)$ and computed $n(t)$ curves of the diurnal electron-density pattern for a given height level, and can be made by analog or digital computers. The coefficients are determined by using as initial data the vertical $N^*(h)$ profiles for a fixed instant of time and is useful when rocket measurements are used as experimental n^* data, which usually give the n^* values for various height h, but for practically the same time t. Ionospheric processes were not taken into account in the determination, and this explains the difference obtained between experiment and computational results given. (J.C.W.)

5274 SOME IONOSPHERIC EFFECTS IN SHORT-WAVE PROPAGATION DURING THE SEPTEMBER 22, 1968 SOLAR ECLIPSE. Smol'yaninov, V. M.; Sorochinskii, M. V.; Feofanov, Yu. V.; Filippov, L. I.; Chernov, P. V. (Inst. of Radio Engineering and Electronics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 299-300(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 354-5(1971).

Experiments show that the reflection frequency of a signal decreases in the evening, starting from sunset, and increases after sunrise. To test the assumption that the same effects appear during a solar eclipse, short-wave propagation observations were performed on a latitudinal link located near the total eclipse zone with its reflection point at 59°N, 53°E during the Sept. 22, 1968, solar eclipse. The equipment synchronized the time at the transmission and reception points to within $\sim 2 \times 10^{-10}$ and permitted measurement of the signal delay time and frequency shift with a high accuracy and resolution. The character of the variations of the frequency shift, of the signal delay time, and of the critical F2-layer frequency is similar to that of their variations during the transition from day to night and night to day (sunset and sunrise). (J.C.W.)

5275 NONLINEAR INTERACTION OF HYDROMAGNETIC WAVES. Gul'el'mi, A. V. (Inst. of Terrestrial Physics, Borok, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 303-5(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 358-60(1971).

The decay instability of hydromagnetic waves with fixed phases was analyzed previously, and a typical case was examined for the magnetosphere when the phases of all interacting waves are not correlated. The plasma is assumed to be homogeneous. The initial equations are the magnetohydrodynamic equations derived from the kinetic equation with a self-consistent field in the drift approximation. The case is examined when there are two transverse waves, an Alfvén wave and a magnetoacoustic wave, and one longitudinal acoustic wave. If magneto-acoustic waves build up and the acoustic and Alfvén waves attenuate, the situation is complex and is difficult to solve. (J.C.W.)

5276 AURORAL ABSORPTION AND DEVELOPMENT OF DR CURRENTS. Driatskii, V. M. (Arctic and Antarctic Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 306-8(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 361-2(1971).

The behavior of auroral absorption during the development of DR currents was investigated using data from twelve magnetic storms in 1964 with a well-defined main D_{st} phase. No high-intensity magnetic storms were observed near the solar activity minimum. The initial and recovery phases were distinct in all storms. The superposition of epochs method was used taking the time of the maximum of the main phase of the magnetic storms as the zero hour. The difference in the behavior of DP disturbances and of auroral absorption during the development of a magnetic storm is associated with the fact that fluxes of particles of different energies are responsible for these phenomena. The ionized region, responsible for auroral absorption, is known to be located at lower heights than the atmospheric levels where

the current systems responsible for geomagnetic disturbances originate. Auroral absorption is associated with fluxes of higher energies. Particles of different energies will not enter the ionosphere simultaneously but at different times, depending on the phase of development of DR currents. (J.C.W.)

5277 EFFECT OF THE INTERPLANETARY MAGNETIC FIELD ON OUTFLOW OF THE SOLAR WIND. Alekseev, I. I.; Shabanskii, V. P.; Shister, A. R. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 167-71(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 201-6(1971).

The effect of the angular inhomogeneity of the interplanetary magnetic field and of the velocity of the solar-wind plasma on the character of flow is analyzed in the magnetohydrodynamic approximation. It is demonstrated that disturbances of the solar-wind parameter that are small near the Sun can increase with distance. The sector structure of the interplanetary magnetic field gives rise to characteristic changes in solar-wind velocity near the sector boundaries. The results obtained agree qualitatively with experimental data. (auth)

5278 CHARACTERISTICS OF PLASMA MOTION IN A DISTURBED MAGNETOSPHERE. Kiselev, B. V.; Raspopov, O. M. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 182-7(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 219-25(1971).

Electron and proton motions in the equatorial plane of the magnetosphere under the effect of a homogeneous electric field and an electric field produced by a geomagnetic DP1 disturbance are computed. The results obtained testify to the significant effect of the electric fields of geomagnetic disturbances on plasma motion in the magnetosphere. (auth)

5279 TRANSPARENCY OF THE MAGNETOSPHERE FOR FAST MAGNETO-ACOUSTIC WAVES. Deutsch, R. V.; Goldenberg, D.; Laur, F.; Maxim, R.; Zoler, D. (Polytechnical Inst., Iasi). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 188-91(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 226-9(1971).

The propagation of magnetoacoustic waves in the Earth's magnetosphere is analyzed. Wave refraction and reflection are investigated. The conditions under which a magnetoacoustic ray that crosses the boundary of the magnetosphere reaches the surface of the Earth are determined. (auth)

5280 DISCRETE MODEL OF THE PLANE FLOW OF A RAREFIED PLASMA AROUND BODIES. Smirnova, V. V. (Moscow Physical-Technical Inst.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 192-7(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 230-7(1971).

A discrete model of the flow of a supersonic, rarefied plasma around bodies is analyzed for a ratio of body dimension to the Debye radius approaching infinity. The results of numerical computations of flow around a plate and a cylinder of circular cross section moving at various velocities are presented. (auth)

5281 CHARACTERISTICS OF THE IONOSPHERIC HALL CURRENT AND OF ITS MAGNETIC FIELD. Davydov, V. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 202-5(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 243-7(1971).

By spreading in the lower layers of a gyrotropic ionosphere, vertical magnetospheric currents form the Hall current. The most characteristic features of this current are examined, as well as the magnetic field below the ionosphere. The lower ionospheric layers are approximated by a double gyrotropic plane. The solution is constructed by introducing two vector potentials. Several idealized models of the source are studied. (auth)

5282 INVESTIGATION OF ELEMENTARY PROCESSES IN THE IONOSPHERE BY MEANS OF (GAS) RELEASES. Danilov, A. D.; Semenov, V. K. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 206-9(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 248-51(1971).

The results of an experimental investigation of the constants of the main photochemical processes directly in the ionosphere are reported. An air-release instrument (AR) and a radio-frequency mass spectrometer were used to obtain information on ion-molecule reaction rates. The mass-spectrometer readings before, after, and during gas (air) releases by means of the AR instrument were analyzed. A preliminary interpretation of the results obtained is given. The method described can probably be used also to estimate the photoionization rate of neutral molecules by solar radiation. (auth)

5283 EXPERIMENT ON THE RECEPTION OF SHORT RADIO WAVES AT A MAGNETICALLY CONJUGATE POINT. Benediktov, E. A.; Ben'kova, N. P.; Bukin, G. V.; (and others). (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 210-13(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 252-7(1971).

The results of short-radio-wave reception at the point magnetically conjugate with Gor'ky are reported. The experiment was performed in October 1968. The receiving equipment was located on the scientific research vessel Borovichi and the transmitter in Gor'ky. Signals with delays from 40 to 110 msec, corresponding to a radio-wave group path from 12,000 to 33,000 km, were recorded. The various possible signal propagation paths are discussed. (auth)

5284 EXPERIMENTAL STUDY ON THE SUPPRESSION OF ONE OF THE MAGNETO-IONIC COMPONENTS DURING WAVE REFLECTION FROM THE F2-LAYER. Berezin, Yu. V.; Gusev, V. D.; Smirnov, V. I. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 214-17(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 258-62(1971).

The results of measurements of the magnitude and stability of suppression of the magnetoionic component with fluctuating elliptic polarization are reported. The suppression method and the experimental procedure are described. The experimental values of the transmission coefficient of the nonsuppressed component are presented and estimates of the correlation coefficient of the scattered field, determining the quality of operation of the suppressing system, are given. The efficiency of the system, tuned to suppression of the elliptically polarized wave, is compared with that of a system designed to suppress circularly polarized waves. (auth)

5285 CROSS-CORRELATION CHARACTERISTICS OF THE DEVIATIONS OF CRITICAL F2-LAYER FREQUENCIES. Rodionov, Ya. S.; Gubenko, V. S. Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 218-21(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 263-7(1971).

The patterns of the quasi-stationary cross-correlation characteristics of f_0F_2 deviations are analyzed. The main emphasis is placed on the relative position of the maxima and on the geographic features of these characteristics. (auth)

5286 RESULTS OF DETERMINATIONS OF THE ELECTRON DENSITY PROFILE IN THE IONOSPHERIC D REGION FROM THE FREQUENCY DEPENDENCE OF RADIO-WAVE ABSORPTION. Belikovich, V. V.; Benediktov, E. A.; Itkina, M. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 222-6(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 268-74(1971).

The results are reported of the determination of the electron-density profile in the ionospheric D region from the frequency dependence of radio-wave absorption during polar-cap absorption events, sudden ionospheric disturbances, and ionospheric disturbances in the auroral zone. (auth)

5287 FREQUENCY DISTRIBUTION OF THE GLOBAL APPEARANCE OF E_s IN 1958 AND 1960 AND THE NATURE OF THIS LAYER. Pisareva, V. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 227-32(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 275-81(1971).

Maps of the frequency of E_s, pE_s, with $f_0E_s > 5$ MNz in 1958 and 1960 are compared and analyzed. The characteristics of pE_s distribution at middle latitudes and those of its diurnal and seasonal patterns are discussed from the viewpoint of the hypothesis of E_s formation as a result of the wind-shear mechanism. (auth)

5288 ION PRODUCTION FUNCTION DURING THE INTERACTION OF ELECTRON FLUXES WITH THE ATMOSPHERE. Osipov, N. K.; Pivovarova, N. B. (Radio Engineering Inst., Moscow. Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 233-4(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 282-4(1971).

The ion production rates at various heights, computed on a digital computer for several models of electron fluxes, described by different energy and angular distributions, are presented. (auth)

5289 VLF-NOISE SPECTRUM IN THE EARTH–IONOSPHERE CAVITY. Nikolaenko, A. P. (Inst. of Radio Physics and Electronics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 235-8(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 285-9(1971).

The excitation of the Earth–ionosphere cavity by lightning discharges is examined with allowance for the splitting of resonance levels by the geomagnetic field. The time dependence of the peak frequency and peak power of oscillations of the first mode is obtained for two models of resonator excitation. The error in the values obtained for the peak frequency of oscillations of this mode is estimated numerically. (auth)

5290 HEIGHT DEPENDENCE OF COEFFICIENT OF ATTACHMENT OF ELECTRONS IN AIR. Mar'yanovskaya, L. L.; Medvedev, Yu. A. Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 239-44(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 290-6(1971).

Laboratory data on the probability of electron attachment in air are analyzed. The energy distribution function of secondary electrons is estimated for ionization by γ radiation. The energy-averaged attachment coefficient of electrons in air of various densities is determined. (auth)

5291 ACCURACY OF DETERMINATION OF RADIO COMMUNICATIONS CHARACTERISTICS BY MEANS OF TRANSMISSION CURVES. Kerblai, T. S.; Kovalevskaya, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 245-50(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 297-302(1971).

Errors in computations by means of transmission curves of the MUF, hop distance, and angles of arrival are estimated. The radio communications characteristics were obtained on a digital computer for an ionosphere consisting of several layers with a parabolic vertical ionization distribution and by superposition of transmission curves on the f(h') curves. The parameters of the layers fed to the computer and used to construct the f(h') curves were the same. (auth)

5292 INTERVALS OF PULSATIONS OF DECREASING PERIOD AND DEVELOPMENT OF ASYMMETRY IN THE RING CURRENT. Mal'tseva, N. F.; Fel'dshtein, Ya. I.; Gul'el'mi, A. V. (Inst. of Terrestrial Physics. Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 255-8(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 308-12(1971).

It is demonstrated that micropulsations of the PDP type are an attribute of an elementary magnetospheric substorm and are associated with the development of cyclotron instability of ring-current protons during asymmetric injections of low-energy protons into the evening sector of the outer radiation zone. The magnetic scattering of protons on hydromagnetic noise may lead to the formation of the DR asymmetry, observed simultaneously with PDP. (auth)

5293 LONGITUDINAL INTENSITY PATTERN OF INNER RADIATION-BELT ELECTRONS AT SMALL HEIGHTS ACCORDING TO PROTON-2 DATA. Petrova, I. V.; Savenko, I. A.; Savun, O. I.; Sharvina, K. M. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 267-9(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 321-4(1971).

Charged particles trapped by the geomagnetic field drift longitudinally to the region of the Brazilian magnetic anomaly. The probability of their loss is great because of the lowering of the mirror points into the dense layers of the atmosphere. The longitude dependence of electron intensity arising at small heights as a result of electron loss and subsequent electron injection was studied for fixed L and B. A longitude dependence, of opposite sign to that of electrons, was previously studied at $L < 1.4$ for particle fluxes recorded by a scintillation counter with a minimal shielding of 3 g/cm^2. For the real geomagnetic field to be computed in the region of the anomaly, a thorough investigation of the accuracy of the L, B coordinates is required. (J.C.W.)

5294 SPORADIC E IONIZATION IN RELATION TO SURFACE PRESSURE DISTURBANCE DURING THUNDERSQUALLS. Datta, R. N. (Univ. of Calcutta). Indian J. Pure Appl. Phys.; 9: No. 6, 394-5(Jun 1971).

A study of sporadic-E ionization in relation to surface pressure disturbance during thundersqualls was made. An increase in overhead sporadic-E ionization appears to be closely associated with the arrival of the moving burst or perturbation in surface pressure during the depression period of thundersqualls. The observational facts are discussed in relation to the present knowledge of gravity waves expected to be generated during such severe atmospheric motions like thundersqualls. A qualitative explanation of the thunderstorm-effect on sporadic-E ionization could be given by considering the physical characteristics of gravity-wave propagation. (auth)

5295 PERIODIC ENERGIZATION OF ELECTRONS DUE TO rf WAVES PROPAGATING THROUGH THE MAGNETOSPHERE. Nath, Omkar; Singh, R. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 9: No. 6, 391-3(Jun 1971).

The cyclotron resonant interaction of spiraling electrons with rf waves was studied. Since in the rf range the refractive index of the magnetospheric plasma is non-unity, the synchronism between spiraling electrons and propagating electromagnetic waves is not established. It is found that the spiraling electrons are periodically accelerated and retarded. The maximum energy gained by spiraling electrons and the periodic time (time between two consecutive maxima and minima of energy) are found to depend upon the background plasma, the frequency of the propagating wave, and the initial energy of interacting electrons. The maximum energy gained and the periodic time are found to increase steadily with the increasing wave frequency. For electrons with initial energy <0.5 MeV, the time period of energy oscillation decreases with the increase of initial energy of the electron, and for electrons of initial energy >0.5 MeV, the periodic time increases with the increase of initial energy of the electron. The maximum energy gain is large for higher-initial-energy electrons. It is concluded that the periodic energy gain manifests some of the periodic phenomena associated with electron precipitation. (auth)

5296 SPORADIC FORMATIONS IN THE IONOSPHERIC F REGION. Chernysheva, S. P.; Mozhaev, A. M.; Sheftel, V. M.; Ryss, I. K. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 283-4(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 338-9(1971).

The appearance of ionograms was used to identify characteristics ascribed to a sporadic-F layer. Vertical sounding data for 1965–1967 were used to establish patterns of sporadic-F occurrence, as well as their relation to other ionospheric phenomena. Nighttime sporadic F is frequently observed simultaneously with oblique reflections and is accompanied by spread F. The oblique reflections can change to sporadic F, which can be associated with the movement of inhomogeneities. Inverse transformations are observed rarely. The mechanisms of daytime and nighttime sporadic-F formation are probably different. Internal gravity waves, producing large-scale ionospheric turbulence and appearing on the ionograms as traveling disturbances, may be responsible for the daytime sporadic F. The largest inhomogeneities may be responsible for the nighttime sporadic F, since the diurnal and seasonal patterns of the S indexes of F scatter are similar to the patterns of the frequency of sporadic-F occurrence obtained. (J.C.W.)

5297 MATHEMATICAL DESCRIPTION OF THE VARIATIONS OF IONOSPHERIC CHARACTERISTICS ASSOCIATED WITH A CHANGE IN SOLAR ACTIVITY. Elizar'ev, Yu. N.; Likhachev, M. A.; Chernyshev, V. I. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 291-3(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 346-7(1971).

Two methods used most frequently to describe the relationship between the variations of ionospheric characteristics and solar-activity levels include the piecewise-linear approximation and approximation by means of a quadratic polynomial. Regression equations were computed to compare the approximation methods of piecewise-linear, nonlinear, and linear with previous nonlinear transformation of the solar-activity index for the noon, f_0F2_{noon}, and minimum, f_0F2_{min}, critical F2-layer frequencies at Tomsk over the 1954–1964 solar-activity cycle. The piece-wise linear approximation leads to simple forecast algorithms. The presence of a break point produces some arbitrariness in the choice of the method of partitioning linear segments, regardless of whether it is done subjectively or some mathematical criterion is used. (J.C.W.)

5298 VARIATIONS OF THE IONOSPHERIC F REGION. Kerblai, T. S. Ionos. Issled.; No. 19, 7-19(1970). (In Russian).

Daily, seasonal, and latitudinal variations of maximum electron concentration (Nm) of the F2 layer are discussed from data of global ionospheric stations. Reasons of actual variations and variations of a simple layer are analyzed from up-to-date data about the upper atmosphere, its composition, and temperature. Explanations of anomaly variations of the F2 layer are briefly discussed. Dependence of ionization of the F2 layer on solar activity is discussed. Four different forms of dependence characterizing separate latitudinal regions of the Earth are obtained. An attempt is made to connect the dependence of Nm on R with changes of aeronomic parameters of the ionosphere during a solar cycle. (40 references) (auth)

5299 IONIZATION DISTRIBUTION WITH HEIGHT AND VARIATIONS IN ITS PARAMETERS ACCORDING TO GROUND-LEVEL VERTICAL SOUNDING DATA. Shapiro, B. S. Ionos. Issled.; No. 19, 20-40(1970). (In Russian).

Methods of calculating the N(h) profiles of the ionosphere from ground-level vertical sounding measurements are discussed. Variations of the main N(h) parameters of the F region under calm and disturbed conditions and the relation of N(h) variations with aeronomic parameters are considered. 54 references. (auth)

5300 IONOSPHERIC DISTURBANCES. Ben'kova, N. P.; Zevakina, R. A. Ionos. Issled.; No. 19, 41-52(1970). (In Russian).

Planetary distribution of disturbances during negative and positive disturbances is described. Variations of height-dependent electron concentration during disturbances are shown on the basis of ground and satellite data. Published hypotheses about the mechanism of decrease of electron concentration during disturbances were discussed. 33 references. (auth)

5301 THEORY OF THE EARTH'S MAGNETOSPHERE AND SOME PROBLEMS OF MAGNETOSPHERE–IONOSPHERE DISTURBANCES. Zhulin, I. A. Ionos. Issled.; No. 19, 53-71(1970). (In Russian).

Certain problems of the dynamics of the magnetosphere and the necessity of their consideration in the study of geomagnetic and ionospheric disturbances are discussed. A general pattern is presented showing the interactions of the solar wind with geomagnetic field, closed and open models of the magnetosphere, and general pattern of the geomagnetic storm development. The adequacy of the magnetohydrodynamic (compression and expansion of the magnetosphere under the influence of forces created in the magnetic field by the particles that penetrated into it or by accelerated particles) is shown, and the classical (ring outer-ionospheric current) explanation of the physical mechanism of development of the major phase of the magnetic storm is given. The mechanisms of introduction and loss of energy in the magnetosphere, effects in the ionosphere in association with convection of plasma in the magnetosphere, and the role of electric fields are discussed. (auth)

5302 ATMOSPHERIC WHISTLERS AND THE OUTER IONOSPHERE. Likhter, Ya. I. Ionos. Issled.; No. 19, 72-89(1970). (In Russian).

The dynamic spectrum of atmospheric whistlers and their main properties are described. Branches of decreasing and increasing frequencies, and "nose" frequencies (frequency of minimum delay) are considered. Dispersion equations are derived for formation of a signal of atmospheric whistlers. Electron density in the top trajectory in an equatorial plane is determined from the value of the "nose" frequency of whistlers and the corresponding value of time delay. These profiles show a smooth decrease of electron concentration. Some difference of summer and winter profiles was observed. Different models of distribution of electron concentration in the outer ionosphere are discussed. During satellite experiments some peculiarities in a lower-frequency part of the spectrum were discovered that were determined by influence of ions and on conditions of propagation of electromagnetic waves. Absolute and relative concentration of ions (hydrogen and helium) is determined in the region near the satellites. (24 references) (auth)

5303 ELECTRIC FIELDS OF THE IONOSPHERE FROM DATA OF ROCKET EXPERIMENTS. Gdalevich, G. L. Ionos. Issled.; No. 19, 90-8(1970). (In Russian).

Some results are briefly described of investigations of electric fields in the ionosphere from instruments installed in rockets and satellites. Some difficulties during such investigations are discussed. The principle of operation of instruments and peculiarities associated with their operation in the ionospheric plasma are considered. It is shown that to determine electric field strength in the ionosphere it is necessary to measure the surfaces of rockets in two diametrically opposite points. A field in three mutually perpendicular directions should be measured for determination of a full strength vector. Values obtained from experiments in 1959–1964 exceed values usually indicated in the literature for middle latitudes. 22 references. (auth)

5304 STUDY OF IONIZATION–NEUTRALIZATION PROCESSES IN THE MIDDLE IONOSPHERE BY RADIOPHYSICAL MEASUREMENTS. Serafimov, K. B. Ionos. Issled.; No. 19, 99-108(1970). (In Russian).

Determination of the main parameters of ionization–recombination processes in E and F1 layers is discussed. A method of determination of α' in the E region is described. Some results of the determination of α'_E are given for radiophysical observations carried out at different angles of the Sun. It is shown that during twenty-four hours an effective recombination coefficient is essentially changed from $\alpha'_E < 10^{-8}$ cm^3 sec^{-1} to $\alpha'_E > 10^{-7}$ cm^3 sec^{-1}. However, in the prevailing part of a day, $\alpha'_E \approx 10^{-7}$ cm^3 sec^{-1}. The indicated changes in α'_E can not be explained by variations of atmospheric temperature only; an essential role should also be played by variations of ionic composition around the clock. For the F1 region some curves of change with height of maximum and minimum values of the effective recombination coefficient are drawn, limiting the actual value of α_{F1}. Possibilities of investigations of α' in the lower part of ionosphere (D region) are discussed. 27 references. (auth)

5305 POSSIBILITIES OF MORE ACCURATE DETERMINATION OF IONOSPHERE STRUCTURE. Serafimov, K. B. Ionos. Issled.; No. 19, 114-23(1970). (In Russian).

Additional absorption measurements are proposed for determination of the ionospheric structure using radiophysical measurements. Nondiverting absorption is analyzed for determination of N(z) profiles in D and intermediate D–E regions and the application of diverting absorption to get independent control data on distribution of H(z) in the middle and higher ionosphere is proposed. Some methods of total absorption are described as diverting and nondiverting, and determination of the structure of intermediate E–F2 region is discussed. Some examples of application of these methods are given. (auth)

5306 SOME CHARACTERISTICS OF THE F1 LAYER. Serafimov, K. B. Ionos. Issled.; No. 19, 124-35(1970). (In Russian).

Conditions of stratification of the F region of the ionosphere leading to appearance of the F1 layer are discussed. Analytical expression is given for conditions of appearance of the well distinguished F1 layer. It can be associated with some change of concentration of atomic oxygen, considering the rate of ionization and zenith angle of the Sun. Another explanation of the appearance can be associated with coincidence or noncoincidence of a maximum rate of ion formation, where effects of linear and quadratic laws of recombination are compared. Some experimental data are described about moments of appearance and disappearance of the F1 layer and also some peculiarities of the behavior of F1. On the basis of experimental data, some estimations of rate of ion formation in the F1 region under high and low activity of the Sun are made. (auth)

5307 CURRENTS IN THE UNDISTURBED IONOSPHERE AND THEIR GEOPHYSICAL EFFECTS. Ben'kova, N. P.; Fatkullin, M. N. Ionos. Issled.; No. 19, 136-74(1970). (In Russian).

A survey of the currents in the ionosphere conducted by direct and indirect methods is presented. The peculiarities of space–time current distribution, which can be discovered when analyzing the outer part of the S_q field are discussed. Rocket researches of currents in the ionosphere are analyzed. The dynamo mechanism of current excitation is discussed in detail; evaluation of current density is carried out according to the data of ionospheric research. The influence of currents on the peculiarities of the ionosphere is considered. 169 references. (auth)

5308 D-REGION ION CHEMISTRY. Ferguson, E. E. (Environmental Research Labs., Boulder, Colo.). Rev. Geophys. Space Phys.; 9: No. 4, 997-1008(Nov 1971).

The status of D-region positive- and negative-ion chemistry is reviewed. In the case of the positive-ion chemistry, the presently accepted ion production rates and ion–neutral reaction scheme are incompatible with the observed qualitative ion composition measurements. The observations indicate that water-ion clusters, $H_3O^+(H_2O)_n$, particularly $H_5O_2^+$, are dominant below 80 km, whereas calculations predict that NO^+ and its hydrates would be dominant. It seems rather likely that an essential element of the physics involved has escaped attention so far. In the case of the negative ions, the few observations only recently obtained are insufficient to critically test the detailed reaction schemes available from laboratory studies. Uncertainties in the concentrations of minor neutral constituents severely limit the ability to predict theoretical negative-ion profiles at present. The first rocket negative-ion observations do support the laboratory-derived prediction of a dominant role for NO_3^- and its hydrates in the D region. 36 references. (auth)

5309 IONOSPHERIC EFFECTS OF BIRKELAND CURRENTS. Cloutier, Paul A. (Rice Univ., Houston, Tex.). Rev. Geophys. Space Phys.; 9: No. 4, 987-96(Nov 1971).

Since Birkeland's observations of high-latitude magnetic perturbations led him to postulate the existence of geomagnetically aligned electric currents, theoretical studies have led to a general understanding of the mechanisms capable of driving such currents and of the processes associated with formation and control of current configurations. Recent advances in experimental techniques have yielded information on the spatial and temporal behavior of such field-aligned Birkeland currents and have established their association to an individual auroral arc and energetic precipitating particles. A brief summary of ionospheric effects related to production, maintenance, and control of Birkeland current systems is given. Available experimental data are discussed in relation to some of these effects. 29 references. (auth)

5310 STRUCTURE OF THE MAGNETOPAUSE. Willis, D. M. (Radio and Space Research Station, Slough, Eng.). Rev. Geophys. Space Phys.; 9: No. 4, 953-85(Nov 1971).

Present understanding of the internal structure of the thin boundary layer, termed the magnetopause, that separates the

distorted geomagnetic field in the magnetosphere from the flow of solar plasma in the magnetosheath is reviewed. The fundamental theoretical concepts of the subject are introduced by considering the structure of the boundary layer that exists when a cold, unmagnetized stream of ions and electrons impinges normally on a vacuum magnetic field. This idealized model indicates how the Earth's magnetic field is confined by the impact pressure of the solar wind, the geomagnetic field being terminated by induced shielding currents flowing in the magnetopause. The various idealizations and approximations in this model, such as the assumption of a cold solar plasma and the neglect of the interplanetary magnetic field, are examined critically. The presence of thermal plasma in the magnetosphere modifies the structure of the boundary layer so that the ions penetrate substantially deeper (~100 km) than the electrons into the geomagnetic field. Complications then arise if the solar plasma has a component of velocity parallel to the confined field, as occurs in the downstream magnetopause that bounds the geomagnetic tail. This additional component of velocity generates electric currents parallel to the magnetic field that may destroy the small-scale equilibrium of the magnetopause and result in a tangential drag on the geomagnetic cavity. The available experimental information on the magnetopause structure is summarized and related to the theoretical investigations. 97 references. (auth)

5311 NIGHT-TIME ENHANCEMENTS IN THE 6 300 A LINE AT SANAE AND THE RELATION TO THE MOVEMENT OF THE AURORAL OVAL. Torr, M. R. (Council for Scientific and Industrial Research, Johannesburg). Ann. Geophys.; 27: No. 2, 201-4(Apr 1971).

Observations of the 6300 Å line at Sanae (70° S, 2° W) in winter show large enhancements in the vicinity of midnight. These enhancements are usually accompanied by E_S and increase in the 30-MHz riometer absorption. For most of the night hours for the months May to July 1964, the ionospheric trace was missing due to nondeviative absorption. The data indicate that energetic electrons are precipitating into the ionosphere; a higher-energy component (>10 keV) produces an increased absorption which results in ionospheric blackout, and a lower-energy component (~2 keV) produces the 6300-Å enhancements. Further, as the enhancements always occur during periods of high magnetic activity, it is suggested that they are due to the diurnal excursion of the auroral oval towards Sanae (59° invariant latitude) which reaches lower latitudes at these times. (France)

5312 SEMI-EMPIRICAL RELATIONSHIPS BETWEEN ELECTRON TEMPERATURE AND DENSITY IN THE IONOSPHERIC F-REGION. Waldteufel, P. (Arecibo Observatory, Puerto Rico). Ann. Geophys.; 27: No. 2, 167-73(Apr 1971).

A previous study of the numerical relations between the electron density and temperature in the ionosphere is extended to a large quantity of new data. The physical interpretation of such laws is discussed in detail. (France)

5313 ENERGETIC PARTICLE ENVIRONMENT AT SYNCHRONOUS HEIGHTS DURING QUIET GEOMAGNETIC PERIODS. Kosik, J. C. Ann. Geophys.; 27: No. 2, 175-80(Apr 1971). (In French).

A coherent coordinate system is established from analytical laws describing the motion of charged particles in the framework of a magnetospheric model. A distribution function for the outer radiation zone was established from satellite data. Conversely, the evolution of the directional fluxes measured from the ATS-1 and OV2-5 satellites can be reconstructed from the distribution function. (France)

5314 ROCKET-BORNE MAGNETOMETER MEASUREMENT OF FIELD-ALIGNED CURRENTS ASSOCIATED WITH AN AURORAL ARC. Park, Raymond John. Houston, Tex.; Rice Univ. (1971). 319p. University Microfilms Order No. 71-26,335.

Thesis.

A rocket-borne experiment to study the currents associated with a quiet auroral arc was conducted at Fort Churchill, Canada, near 8 P.M. local time on February 26, 1969. The magnetic field near the arc was measured with a vector magnetometer system, while a lunar aspect sensor provided information on the orientation of the payload. The techniques for analyzing the magnetometer data to obtain the vector components of the magnetic field are described in detail. The changes in magnetic field along the flight path were used to determine the most-probable three-dimensional current system, concluded to be a northwestward electrojet and two oppositely directed sheet currents flowing along the geomagnetic field lines. The electrojet and the planes containing the field-aligned sheet currents were approximately parallel to the auroral arc. The electrojet was a localized current of 7×10^3 amperes flowing in a region having a 20-km width and a mean altitude of 119 km. An upward field-aligned current of 0.16 amp/m was detected above this region, with an equal downward current to the south. The upward sheet current had a thickness of about 16 km; the location and thickness of the downward current were uncertain, although most of the current was within roughly 30 km of the upward current. The field-aligned currents were presumably connected by a transverse current below 130 km. The configuration of currents near the auroral arc is similar to that in a theoretical model proposed by Boström (1964). A basic difference in the directions of the currents was interpreted in terms of the direction of the driving electric field. The currents were compared with fluxes of 2- to 18-keV electrons detected in a separate experiment aboard the rocket. (TSS) (Diss. Abstr. Int., B)

5315 AURORAL BRIGHTNESS FLUCTUATIONS. Pemberton, Eric Vernon. Saskatoon, Can.; Univ. of Saskatchewan (1971). 195p. University Microfilms Order No. 71-26,235.

Thesis.

Spatial and temporal characteristics of auroral-brightness fluctuations were studied with an array of 5 photometers. Auroral-brightness fluctuations caused by bunches of electrons (or protons) mirroring in the ionosphere at conjugate locations were studied. It was found that in the frequency range of study ($0.05 \leq f \leq 15$ Hz) four characteristic fluctuations occur. The dominant fluctuation is irregular at near 7-sec period in the morning hours, occurring with slightly longer period in the evening. Fluctuations at 2.4-sec period occur after local midnight, and short bursts of 3-Hz activity occur near dawn. All of the above fluctuations are strongly responsive to the level of geomagnetic disturbance, and occur chiefly in the recovery phase of auroral substorms. The fluctuations are not related to visible auroral forms, being often from the subvisual aurora and the fluctuation activity is homogeneous over large regions of the auroral surface. The fluctuation activity is confined to the equatorward side of a visible auroral display. Fluctuations near 10 Hz (flickering) are characteristic of the auroral breakup phase. Several arguments are given to show that mirroring particle bunches are not a likely cause of the fluctuations. In the mechanism suggested for the irregular 7-sec period fluctuations, an instability in the neutral sheet causes a contraction of a field line toward the Earth, energizing a number of neutral-sheet particles that divides and causes a brightness pulsation simultaneously in both hemispheres on the Earth's night side and triggering a similar event succeeding it. Several closely related phenomena are suggested as originating in the same manner. Characteristic fluctuations at 2.4-sec period and 3 Hz may be turned on by the above process. (Diss. Abstr. Int., B)

5316 FULL-WAVE SOLUTION FOR THE TRANSMISSION OF ULF AND ELF WAVES THROUGH THE IONOSPHERE. Shaeffer, D. Lynn. Pittsburgh; Univ. of Pittsburgh (1971). 244p. University Microfilms Order No. 71-23,951.

Thesis.

Full-wave solutions have been found for plane wave and localized disturbances in the ulf (micropulsation) and elf frequency ranges. Slow and fast wave disturbances incident at 5000 km at frequencies of 100, 3.0, 1/3, and 1/300 Hz were analyzed. A model ionosphere developed from existing rocket and satellite data for conditions of midday and midlatitude at sunspot minimum was used in the calculations. The cold-plasma dispersion relation was written conveniently in terms of the localized disturbance factor and the ionospheric conductivity tensor elements. The localized disturbances were found to produce large vertical electric fields in the neutral atmosphere for the incident slow waves in the micropulsation range and the incident fast wave at 100 Hz. Localization causes strong-mode coupling in the lower D region, and the coupling coefficients are larger than the quartic roots at 1/300 Hz. Charge exchange of O^+ and O results in an enhanced Pedersen conductivity region which, in some cases, acts as a cavity wall for wave energy storage. Charge exchange also causes some absorption at Pc1 frequencies in the range 150 to 250 km. The conductivity of the Earth's surface is included and found to result in almost total reflection at ground level for all frequencies considered. Incident slow-mode signals at 3.0 Hz undergo polarization reversal at 1000 km and then propagate mostly in the R mode through the ionosphere. At 4000 km plasma-drift velocities between 0.1 and 1.0 km/sec are sufficient for the incident slow waves to excite typical Pc1 and Pc5 ground-observed signals. (Diss. Abstr. Int., B)

5317 VECTOR MEASUREMENTS OF THE ION TRANSPORT VELOCITY WITH APPLICATIONS TO F-REGION DYNAMICS. Behnke, Richard Alan. Houston, Tex.; Rice Univ. (1971). 159p. University Microfilms Order No. 71-26,255.

Thesis.

The measurements of vector ion-transport velocities in the F region at Arecibo are presented for several winter days during 1969–1970. To make the vector measurement, first the line-of-sight plasma motion is determined from the Doppler shift of the

returned incoherent scatter spectrum. Next, the radar beam is pointed sequentially toward (geomagnetic) north, west, and south. From the three line-of-sight measurements the transport velocity vector can be reconstructed and studied. Meridional neutral winds in the F region can be found with a knowledge of the transport velocity component parallel to the magnetic field. The obtained winds show a diurnal pattern that is quite different from theoretical predictions. Results indicate the presence of an unknown neutral-wind driving force that significantly modulates the predicted pattern which is based on worldwide pressure gradients due to solar heating. From the transport velocity component perpendicular to the magnetic field, the electric field can be found, since in the F region such motion can only arise from $\underset{\sim}{E} \times \underset{\sim}{B}$ drifts. Comparison to drifts predicted by the dynamo theory shows good agreement only in the daytime. Additionally an unexpected coupling between the transport motion perpendicular and parallel to the magnetic field is observed at night. The coupling is such that ionospheric plasma tends to move only horizontally. This is suggested to be due to an F-region polarization field, set up by diverging $\underset{\sim}{E} \times \underset{\sim}{B}$ currents driven by the neutral winds and diffusion forces. Large variations in the height of the F layer during the night are ascribed to specific changes in the F-region neutral winds. (Diss. Abstr. Int., B)

5318 ROCKET MEASUREMENTS OF FIELD-ALIGNED CURRENTS AND ENERGY SPECTRA OF CHARGED PARTICLES IN AN AURORAL DISPLAY. Choy, Lawrence Wah. Durham, N. H.; Univ. of New Hampshire (1971). 149p. University Microfilms Order No. 71-25,411.

Thesis.

A Nike–Tomahawk rocket equipped to measure electric and magnetic fields and charged particles from a few eV to several hundred keV energy was flown into an auroral band from Fort Churchill on April 11, 1970. The particle detectors were oriented so as to measure net field-aligned currents. At the region north and away from the auroral band, an upward electron current (electrons going away from Earth) was discovered. This field-aligned current consisted of electrons with energies less than 600 eV and had a magnitude that varied from 10^{-8} to 10^{-7} amp-m^{-2}. At the northern boundary of the auroral luminosity, an intense downward electron current sheet was measured. The electrons responsible for the current sheet had a mean energy of 0.5 keV and resulted in a field-aligned current about an order of magnitude greater than that produced by the more-energetic electrons responsible for the luminosity. The current sheet separated the region of hard spectra magnetically tied to the aurora from that characterized by soft spectra north of the luminosity. The spectrum of particles north of the aurora was very soft, with shape and intensity similar to that consistently seen in the tail of the magnetosphere by the Vela spacecraft. When intense downward field-aligned electron currents were observed, the direction of the electric field in the ionosphere pointed westward or southwestward. Outside the region of luminosity, when the substorm was recovering, the electric field switched to an eastward direction as the magnitude of the downward field aligned electron currents decreased. This correlation appears to be a spatial effect, although it could be interpreted temporarily as a characteristic of magnetospheric tail fields during the substorm recovery. Electrons from a few to several keV were responsible for the auroral luminosity, and they represented a current (conventional sense) away from the atmosphere on the order of 5×10^{-7} amp-m^{-2}. Changes in the fluxes of the particles are observed to be the cause of luminosity variations. Enhancements in the transverse electric-field magnitude are correlated with auroral motions and increments in the overall luminosity. The E × B drift imposed on the primary beam can account for auroral motions observed. (Diss. Abstr. Int., B)

5319 THERMAL AND QUASI-ENERGETIC PLASMA FLOW IN THE MAGNETOSPHERE: THEORETICAL STUDY. Chen, Abel Jer-jiunn. Houston, Tex.; Rice Univ. (1971). 171p. University Microfilms Order No. 71-26,273.

Thesis.

A simple computational model with a uniform convection electric field and a dipole magnetic field were used to calculate drift paths for low-energy plasma in the magnetosphere. Unlike other particles, the flow patterns for protons with some relative magnetic moments exhibit complicated double forbidden regions, so that these protons from the magnetotail can penetrate very close to the Earth. A detailed study of drift paths and particle loss leads to two important conclusions suggested before on a more qualitative basis. One is that, through enhancement of the convection field, protons convected from the magnetotail to L = 3 to 4 could be responsible for stormtime ring currents. The other is that the asymmetry of the particle trajectories coincides well with the observed asymmetry of the ring currents. Computational models were used to study the formation and morphology of the plasmasphere by the time-dependent convection field. In the first set of models, at time $t \geq 0$, the magnitude of the convection field changes quickly from E_i to E_f. Computed particle trajectories illustrate several observed effects, in particular, the radial motion of the plasmapause and the surge and untrapping of the evening bulge. The long-term evolution of the plasmapause for $E_i > E_f$ shows that the bulge forms a tail-like structure around the plasmasphere. In a second set of models, two types of gusty fields were considered, one having identical gusts and the other having each large gust followed by two smaller ones. A simple analytic model is used to show that a gusty convection field should have a major effect on the size of the plasmasphere if the field has large Fourier components close to the drift period of cold plasma. The computer models indicate that, for identical gusts occurring every 8 to 10 hours, the fractional change in the size of the plasmasphere is ≤1.5% that of the plasmasphere for a time-independent convection field with the same average value. However, for nonidentical gusts with the same average, the computed plasmasphere becomes noticeably smaller (fractional change ~8%). (TSS) (Diss. Abstr. Int., B)

5320 INTERPRETATION OF PLASMA RESONANCES OBSERVED BY IONOSPHERIC TOPSIDE SOUNDERS. Dougherty, J. P.; Watson, S. R. (Cambridge Univ., Eng.). Advan. Plasma Phys.; 4: 1-41(1971).

A review is given of theoretical work on plasma resonances from ionospheric topside sounders. Some of the complex properties of plasma are described, namely: the propagation of Bernstein modes and the role of the vector group velocity. 51 references. (M.O.W.)

5321 AFTERNOON AND EVENING MAXIMA IN THE F2 LAYER. Serafimov, K. B.; Gorinov, N. Ionos. Issled.; No. 19, 109-13(1970). (In Russian).

An afternoon increase of ionization is a specific characteristic motion of the F2 layer. It is shown that specific parameters of afternoon and evening maxima depend on season, zenith angle of the Sun, and solar activity. The values of the maxima are greatest with maximum activity, and solar-activity variations do not greatly influence the initial appearance of these maxima. (auth)

5322 STUDY OF THE PASSAGE OF AURORAL X-RAYS THROUGH THE ATMOSPHERE, FOR INTEGRAL SPECTRAL MEASUREMENTS WITH COLLIMATED AND OMNIDIRECTIONAL DETECTORS. Pilkington, G. R. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). SPARMO Bull.; 4: No. 4, 307-20 (Jul 1971).

Auroral x-ray propagation in the atmosphere was studied using the Monte Carlo method. The spectra of different energy sources and source geometries were investigated from integral spectral measurements made at balloon altitudes with collimated and multidirectional detectors. For a given-energy-source spectrum, the observed ratios of higher-energy integral channels (e.g., N(>75 keV)/N(>50 keV) etc.) are not seriously affected by the source geometry at a particular atmospheric depth, when multidirectional detectors are employed. The channel ratios can be related to the x-ray source and hence electron spectrum, provided some simple spectral form can be assumed. On the contrary, channel ratios for collimated detectors are strongly dependent on the location and size of the source. This indicates that spectral changes observed by such detectors must be viewed with considerable caution, unless detailed information on the source geometry is available. The energy spectrum of the electron source at the top of the atmosphere can be deduced from integral spectral measurements obtained with multidirectional detectors assuming a simple form for the energy source spectrum. (France)

5323 INCREASE OF SOLAR PROTON INTENSITIES MEASURED BY SATELLITE PROTON-3. Zel'dovich, M. A.; Kovrizhnykh, O. M.; Madeev, M. O.; Savenko, I. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 2, 229-30(Mar-Apr 1970). (In Russian).

Proton-3 was launched on July 6, 1966 at 15 hr, 45 min Moscow time to monitor the increase in proton flux in the energy range 100 to 1000 MeV. The solar proton spectra are shown for the July 7, 1966 period 4 hr, 5 min to 5 hr, 30 min Moscow time, at which time Proton-3 had reached an apogee of 630 km and a perigee of 190 km at 64° inclination of orbit. From the preliminary data, the solar proton integral spectra had a form $N \sim E^{-1.5}$. (J.C.W.)

5324 NORTH–SOUTH ASYMMETRY OF SOLAR-PARTICLE FLUXES IN POLAR-CAP REGIONS. Domingo, V.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). J. Geophys. Res.; 76: No. 34, 8159-64(1 Dec 1971).

On January 24, 1969, an experiment on the Esro 1/Aurorae satellite recorded a flux over the central north pole that at times was a factor of 7 greater than that seen over the south pole. This asymmetry is discussed in relation to the interplanetary-field direction measured at the same time by the Heos spececraft, and comparison is made with the opposite asymmetrical configuration

observed by Evans and Stone (1969) on November 2, 1967. From the evidence of two events it would appear that a southward interplanetary field plays a significant role in permitting direct access, while the magnitude and polarity of the asymmetry are determined by, respectively, interplanetary-particle anisotropy and the "toward" or "away" nature of the field. (auth)

5325 PHOTOELECTRON FLUXES IN THE IONOSPHERE COMPUTED BY A MONTE CARLO METHOD. Cicerone, R. J.; Bowhill, S. A. (Univ. of Illinois, Urbana). J. Geophys. Res.; 76: No. 34, 8299-8317(1 Dec 1971).

The motions of photoelectrons in the ionosphere were simulated by a Monte Carlo technique developed specifically for this purpose. The physical model adopted for these simulations included transport effects, photoelectron collisions (both elastic and inelastic) with the three major neutral gases, and a continuous energy loss to ambient thermal electrons. The Monte Carlo approach allowed angular scattering due to photoelectron–neutral collisions to be considered in a complete and natural fashion. Two model atmospheres corresponding to two levels of solar activity were treated. For each model, photoelectron fluxes were computed as functions of altitude energy, and pitch angle. A photoelectron escape flux of 2.5×10^8 cm^{-2} sec^{-1}, carrying 3.6×10^9 eV cm^{-2} sec^{-1}, was calculated for the model having moderate solar activity. The pitch-angle distribution of the escaping flux was found to be skewed toward small pitch angles. The magnitudes of the computed fluxes and other features of the results, such as the albedo of the atmosphere, are discussed and are compared with satellite and radar measurements and with the results of other calculations. (auth)

5326 NEUTRAL COMPOSITION VARIATION ABOVE 400 km DURING A MAGNETIC STORM. Taeusch, D. R. (Univ. of Michigan, Ann Arbor); Carignan, G. R.; Reber, C. A. J. Geophys. Res.; 76: No. 34, 8318-25(1 Dec 1971).

Data from the neutral atmospheric composition experiment launched aboard Ogo 6, June 5, 1969, are examined for September 27 through October 3, 1969. Several magnetic storms occurred during this time, and the response of the neutral atmosphere to the energy deposition causing these storms was studied. The data indicate that the major portion of the energy is deposited at high latitudes, causing enhancements in N_2 densities corresponding to Jacchia (1970) temperature increases on the order of 400 to 500°K. The time difference between atmospheric response and magnetic activity appears to be very short at high latitudes. The O/N_2 ratio variations suggest dynamic processes that cause a circulation in the atmosphere that is upward at the pole with subsidence at the equator. (auth)

5327 VERTICAL MOTIONS OF THE MIDLATITUDE F2 LAYER DURING MAGNETOSPHERIC SUBSTORMS. Park, C. G. (Stanford Univ., Calif.); Meng, C.-I. J. Geophys. Res.; 76: No. 34, 8326-32(1 Dec 1971).

Ground-based ionosonde records from midlatitude stations during winter nights are used to study vertical motions of the F2 layer associated with magnetospheric substorms. The results show that during substorms the F2 layer is lifted upward in the pre-midnight sector and pushed downward in the post-midnight sector. These motions are interpreted in terms of $E \times B$ drifts, the electric field being eastward on the eveningside and westward on the morningside. The results emphasize the importance of substorm effects on the midlatitude F region and the potential of ground-based hf sounding techniques in studying magnetospheric substorms. (auth)

5328 PROBE AND RADAR ELECTRON TEMPERATURES IN AN ISOTROPIC NONEQUILIBRIUM PLASMA. Hoegy, W. R. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: No. 34, 8333-40(1 Dec 1971).

Electron temperatures measured by electrostatic probes and radar backscatter are distinct physical quantities, the temperature from each technique determined from a different moment of the electron-distribution function. Numerical inequality of temperatures results from a non-Maxwellian electron-distribution function or, equivalently, from a nonequilibrium electron plasma. Probe and backscatter electron temperatures are studied for low- and high-energy (isotropic) distortions of the distribution function. The nonequilibrium plasma generally produces higher probe than backscatter temperatures; however, the temperature difference is small for distortions due to realistic photoelectron populations. If the ionosphere is in a highly nonequilibrium state, probe and backscatter temperatures would differ from the temperature characterizing the average electron kinetic energy, and a single temperature applicable to a variety of physical processes would no longer exist. (auth)

5329 RADAR STUDIES OF THE EQUATORIAL ELECTROJET AT THREE FREQUENCIES. Balsley, B. B. (NOAA Research Labs., Boulder, Colo); Farley, D. T. J. Geophys. Res.; 76: No. 34, 8341-51(1 Dec 1971).

Radar measurements at 16.25, 49.92, and 146.25 MHz of electrojet irregularities at Jicamarco indicate that (1) the plasma-wave velocities observed for the type-I (two-stream) irregularities are approximately proportional with ratios 0.9:1.0:1.1; (2) these velocities can vary throughout the day by as much as 50%; (3) the mean velocities of the type-II irregularities are equal at 16 and 50 MHz; (4) the strength of the type-II irregularities decreases much more rapidly with wavelength than the strength of the type I, and as a result the type-II signal predominates at 16 MHz, but only type I is observed at 146 MHz; and (5) the dependence of the scattering cross section on electrojet strength is much more pronounced at 146 MHz than at 16 MHz, probably because of the different character of the signals. On the basis of these and other observations, it is concluded that (1) the Doppler velocity of the type-I echoes corresponds to the acoustic velocity rather than the electron streaming velocity, a result contrary to the prediction of linear theory; (2) the acoustic velocity varies with wavelength in at least approximate agreement with theory; and (3) the type II-irregularities observed by the radar are probably not excited directly, but rather result from nonlinear interactions among larger irregularities. (auth)

5330 STUDIES OF POSITIVE-ION COMPOSITION IN THE EQUATORIAL D-REGION IONOSPHERE. Goldberg, R. A.; Aikin, A. C. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: No. 34, 8352-64(1 Dec 1971).

Two daytime D-region positive-ion composition measurements at Thumba, India, are presented for solar-zenith angles of 53.2 and 27.8°. Comparison of upleg ram with downleg wake data shows a large increase in the concentration of heavy ions 48^+, $NO^+ \cdot H_2O$; 55^+, $H_3O^+ \cdot (H_2O)_2$; and $M^+ > 65^+$ for the downleg reduced-shock condition. Peak concentrations of 48^+ and 55^+ occur at unit optical depth for Lyman-α radiation. The ion 37^+, $H_3O^+ \cdot H_2O$, is dominant for $\chi = 27.8°$ but not for $\chi = 53.2°$, consistent above 80 km with an origin from the x-ray production of O_2^+. Laboratory measurements have shown that the ion, NO^+, can be transferred to heavy hydrates 48^+, 55^+, and $M^+ > 65^+$ by a reaction chain starting with $NO^+ + X + M = NO^+ \cdot X + M$, where X can be O_2, N_2, CO_2, or a combination of all three depending on the rate of reaction. This chain, together with a similar reaction scheme starting with O_2^+ and ending in 19^+, 37^+, and heavier clusters, is used to provide a consistent explanation for the hydrated ions observed in the D region. (auth)

5331 AMPLITUDE DISTRIBUTIONS OF D-REGION PARTIAL REFLECTIONS. von Biel, H. A. (Cornell Aeronautical Lab., Inc., Buffalo). J. Geophys. Res.; 76: No. 34, 8365-7(1 Dec 1971).

The results obtained from a D-region echo-amplitude-distribution program are presented. For scattering heights above 80 km, the experimental data indicate that coherent scattering frequently contributes to the total echo power, whereas for heights below 80 km, the echo-amplitude distributions are predominantly Rayleigh-like in character. (auth)

5332 VIBRATIONAL POPULATION OF THE $A^3\Sigma_u^+$ AND $B^3\pi_g$ STATES OF N_2 IN NORMAL AURORAS. Cartwright, D. C. (Aerospace Corp., El Segundo, Calif.); Trajmar, S.; Williams, W. J. Geophys. Res.; 76: No. 34, 8368-77(1 Dec 1971).

New electron impact excitation cross sections for the 6 lowest triplet states (A, B, W, C, E, D) of N_2 were used and the coupled equations of statistical equilibrium solved to obtain the vibrational population of each electronic state. The results show that cascade from high levels of the $A^3\Sigma_u^+$ state and from the $W^3\Delta_u$ state is significant in populating the lower vibrational levels of the B state and hence the character of its "apparent" excitation cross section. For the B state excited under auroral conditions, the fraction of the total population due to cascade processes exceeds 25% for all levels lower than 7 and is greater than 80% for B(v' = 0). For the A state under similar conditions, cascade from the B state contributes 50% or more of the total vibrational population for levels lower than 7, and 80% or more for levels below 4. For levels of the A state greater than 7, the A → B transitions depopulate the levels rapidly and indicate that the Vegard–Kaplan emissions from these higher levels will be weak or totally absent in normal auroras. (auth)

5333 VACUUM-ULTRAVIOLET SPECTRA OF THE LATE TWILIGHT AIRGLOW. Buckley, J. L.; Moos, H. W. (Johns Hopkins Univ., Baltimore). J. Geophys. Res.; 76: No. 34, 8378-83(1 Dec 1971).

Sounding rocket spectra of the late twilight (solar-zenith angle of 120°) ultraviolet airglow between 1260 and 1900 A are reported. The only observed features are O I 1304 and 1356. When the instrument looked at an elevation of 17° above the western horizon, the brightnesses were 70 and 33 rayleighs, respectively. The upper limits on the total intensity of the LBH and VK systems of N_2 were 26 ± 26 and 55 ± 55 rayleighs, respectively. An estimate

shows that a large part of the O I emissions may be due to excitation by conjugate point electrons. (auth)

5334 ADIABATIC PARTICLE ORBITS IN A MAGNETIC NULL SHEET. Sonnerup, B. U. Oe. (European Space Research Inst., Frascati, Italy). J. Geophys. Res.; 76: No. 34, 8211-22 (1 Dec 1971).

The adiabatic theory is presented for charged particles moving in a region where the main component of the magnetic field reverses its direction. The unperturbed field configuration is one-dimensional and involves two regions of uniform and opposite magnetic fields separated by a reversal region of small but finite extent. The adiabatic theory is capable of describing particle orbits when gradual spatial and/or temporal field variations are added to this configuration. Several applications are given. These include orbits during a null-sheet compression, orbits in the sheets studied by Alfvén and Speiser, and orbits in the vicinity of the magnetic null line of the so-called field-reconnection geometry. (auth)

5335 SOURCE AND LOSS PROCESSES OF PROTONS OF THE INNER RADIATION BELT. Farley, Thomas A. (Univ. of California, Los Angeles); Walt, Martin. J. Geophys. Res.; 76: No. 34, 8223-40(1 Dec 1971).

The adequacy of the known source and loss processes to populate the inner radiation belt with protons is examined by calculating the equilibrium trapped-proton distribution that would result from decay of albedo neutrons, energy-loss collisions, and radial diffusion by changes in the third adiabatic invariant. The strength of the neutron source and the rates of atmospheric energy loss are obtained from available theoretical and experimental data, and the radial-diffusion coefficient is adjusted to give agreement between theory and experiment for equatorially trapped protons with first invariants between 200 and 3000 MeV gauss^{-1}. Since there is strong evidence for additional loss mechanisms above L = 1.8, this comparison is limited to L < 1.7, and in the calculation all processes above that boundary are simulated by setting the fluxes at 1.7 equal to the experimental values. The flux intensities, energy spectrums, and radial distributions obtained by this theory are in good agreement with observations, and the radial-diffusion coefficient required is consistent with diffusion coefficients derived by a variety of other methods. It is concluded that these processes are adequate to explain the gross characteristics of protons of the inner radiation belt, although off-equatorial protons were not considered and the solar-cycle variations were not computed. (auth)

5336 POLEWARD EXPANSION OF THE AURORAL OVAL AND ASSOCIATED PHENOMENA IN THE MAGNETOTAIL DURING AURORAL SUBSTORMS. II. Hones, E. W. Jr.; Akasofu, S.-I.; Bame, S. J.; Singer, S. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 76: No. 34, 8241-57(1 Dec 1971).

In the magnetotail at the distance of the Vela satellite orbits (r ~ 17 to 20 R_E) the plasma sheet becomes thin early in a polar magnetic substorm and then becomes thick again late in the substorm. Also, the thinning process consists not only of a reduction in the thickness of the plasma-containing region but also of a decrease of the plasma energy density throughout the region, except perhaps very near the neutral sheet. The process of plasma-sheet thinning is examined in substorms for which all-sky photographs as well as ground-based magnetograms were available. Thus, the thinning process could be correlated with features of both the auroral substorm and the polar magnetic substorm. The following phenomena usually begin simultaneously to within the few-minutes accuracy of the timing of the measurements: (a) plasma-sheet thinning, (b) development of negative magnetic bays in the nightside auroral oval (independent of whether these develop rapidly or gradually), (c) development of positive magnetic bays at nightside low-latitude stations, and (d) brightening and poleward motion of auroras in the nightside auroral oval. These results are entirely consistent with, although more detailed and precise, than our earlier reports that plasma-sheet thinning and negative magnetic-bay development in the auroral zone proceed together. The study does not help to resolve the presently existing controversy as to whether or not some magnetospheric substorms have a "development phase" preceding the classical substorm "onset" features, because none of the substorms examined seemed clearly to have a "development phase". After its onset, plasma-sheet thinning continues, often for half an hour to an hour, as the aurora moves poleward. The poleward motion of the aurora may be indicative of the development of a new hot plasma sheet within the old cool plasma sheet as the latter becomes thin. (auth)

5337 MEASUREMENTS OF HIGHLY COLLIMATED SHORT-DURATION BURSTS OF AURORAL ELECTRONS AND COMPARISON WITH EXISTING AURORAL MODELS. O'Brien, Brian J. (Dept. of Environmental Protection, Perth, Australia); Reasoner, David L. J. Geophys. Res.; 76: No. 34, 8258-78(1 Dec 1971).

The pitch-angle distributions, energy spectra, and temporal and spatial variations of auroral electrons with energies from 40 eV to 100 keV were measured with the Twins 2 rocket payloads to an altitude of 800 km. Enhancements of electrons with energies of ~5 keV, pitch angle $\alpha \leq 10°$, and intensities of up to 5×10^8 particles cm^{-2} sec^{-1} ster^{-1} were observed occasionally. The enhancements were sometimes by a factor of 10, even while electrons with energies of ~12 keV at these pitch angles showed no changes (nor did those with energies between ~40 eV and 100 keV at $30° \leq \alpha \leq 60°$). The bursts were thought to be temporal in origin, and they lasted for the minimum resolvable time of ~0.1 sec up to times of several seconds. The altitude of the source of the bursts of field-aligned electrons is believed to be less than 1 R_E, and their occurrence is not clearly related either to the ever-present auroral continuum nor to the electrons with a few keV that cause auroral luminosity. Several existing theories of auroral-particle acceleration and/or precipitation were examined, and are shown to be inadequate (as presently formulated) to individually explain all the observations. A potpourri model of adaptations of all these theories is shown to be adequate, but its reality is not otherwise established. Field-line merging and diffusion by wave–particle interactions are considered to be commonly occurring phenomena. (auth)

5338 MIDDAY AURORAL OBSERVATIONS IN THE OVAL, CUSP REGION, AND POLAR CAP. Romick, G. J.; Brown, N. B. (Univ. of Alaska, College). J. Geophys. Res.; 76: No. 34, 8420-4(1 Dec 1971).

Combined photographic and photometric measurements made on the 1969 NASA airborne expedition yield a description of the midday oval, cusp region, and polar cap auroral precipitation at low magnetic activity (Kp = 0, 1+). The observations delineate three regions through the description of the type of aurora observed and the photometrically inferred change in energy of the particles: (1) the region in and equatorward of the oval where >3-keV electrons are associated with λ6300/λ4278 ratios ≦1 and with a diffuse glow or structured arcs; (2) the cusp region where electrons of several hundred electron volts and spikes of more energetic electrons are associated with λ6300/λ4278 ratios between 10 and 35 in broken, fragmented, rayed features and patches; (3) the polar cap where discrete Earth–Sun-aligned arcs have height luminosity profiles in λ5577, λ6300 [O I], and λ4278 (N_2^+) that suggest incoming electrons with an energy spectrum of 2-keV characteristic energy above a low-energy (few hundred electron volts) background. (auth)

5339 ANALYTIC EXPRESSION FOR THE ENERGY-TRANSFER RATE FROM PHOTOELECTRONS TO THERMAL ELECTRONS. Swartz, Wesley E. (Pennsylvania State Univ., University Park); Nisbet, John S.; Green, Alex E. S. J. Geophys. Res.; 76: No. 34, 8425-6(1 Dec 1971).

An analytic form is given for the energy-transfer rate from photoelectrons to thermal electrons. The expression fits the classical formulation of Itakawa tnd Aono (1966) at low energies and gives a smooth transition to fit the quantum-mechanical equation of Schunk and Hays (1971) at higher energies. The corresponding loss function or stopping power has a form that is convenient in auroral and dayglow calculations. (auth)

5340 SOLAR X-RAY CONTROL OF E AND SPORADIC-E LAYERS OF THE IONOSPHERE. Vij, K. K.; Hislop, R. (Univ. of Calgary, Can.). J. Geophys. Res.; 76: No. 34, 8441-4(1 Dec 1971).

The daily average of the solar x-ray flux in the 8- to 20-A and 44- to 60-A bands and the midday values of E- and sporadic-E-layer parameters (f_0E and (f_bE_s)) from the typical midlatitude station of Washington, D. C. were used for the study. Both the x-ray control of the regular E layer from Nov. 1966 to July 1968 and the relation between solar x rays and f_bE_s were investigated. From the analyses the following comments can be made: (1) the 44- to 60-A solar flux is more important than the 8- to 20-A part for the formation of normal E layer; (2) the 44- to 60-A flux has more control on the formation of the sporadic-E layer; and (3) the solar flux responsible for the formation of the E layer, and consequently also responsible for the formation of the sporadic-E layer for the midlatitude stations, can extend up to 100 A. (J.C.W.)

5341 ELECTRON PRECIPITATION ASSOCIATED WITH DISCRETE VERY-LOW-FREQUENCY EMISSIONS. Rosenberg, T. J. (Univ. of Maryland, College Park); Helliwell, R. A.; Katsufrakis, J. P. J. Geophys. Res.; 76: No. 34, 8445-52 (1 Dec 1971).

Previous experiments have shown indirect evidence linking discrete vlf emissions to electron precipitation by the association between chorus and electron microbursts, a positive correlation between chorus and riometer absorption, and sudden reduction in strength of vlf signals observed on satellites crossing the plasmapause toward high latitude. Results of a wave–particle experiment

conducted near the plasmapause at Siple station, Antarctica are reported here. Bremsstrahlung x rays, arising from the precipitation of energetic electrons, were recorded. Discrete emissions can be stimulated artifically by using ground-based transmitters operating in the vlf range. The observations reported indicate that the generation of discrete emissions causes the precipitation of energetic electrons, and it is seen that controlled stimulation of vlf emissions will lead to the controlled precipitation of energetic electrons into the ionosphere. (J.C.W.)

5342 PHASE VARIATION OF A VERY ACCURATE RADIO FREQUENCY SIGNAL DUE TO THE SOLAR ECLIPSE. Sadeh, Dror (Tel-Aviv Univ., Ramat-Aviv, Israel). J. Geophys. Res.; 76: No. 34, 8427-9(1 Dec 1971).

A delay in the time of arrival of time ticks during the solar eclipse on March 7, 1970, was observed. These time ticks are transmitted by the Loran-C system from Cape Fear, North Carolina, and are received in Washington, D. C. No change in temperature, pressure, water-vapor pressure, or ion concentration in the atmosphere can explain this time delay. The presence at 10 km of 100 times more electrons per cm^2 than previously believed could explain all the experimental observations. (auth)

5343 PULSATION PHENOMENA OBSERVED IN LONG-DURATION VLF WHISTLER-MODE SIGNALS. Bell, T. F.; Helliwell, R. A. (Stanford Univ., Calif.). J. Geophys. Res.; 76: No. 34, 8414-19(1 Dec 1971).

Whistler-mode signals from station NAA (14.7 and 17.8 kHz), Cutler, Maine, show periodic fluctuations ("pulsations") in amplitude and bandwidth. The data were recorded at Eights station, Antarctica, during unmodulated ("key-down") transmissions from NAA lasting up to 2 min. In three of the four instances, the pulsations consist of a series of moderate enhancements of the amplitude and bandwidth of the signal, each pulsation lasting about 50 msec. The fourth instance, however, was unusual in that the key-down signal exhibited remarkably regular and intense amplitude variations. In all four occurrences, the period of the pulsation was in the range from 0.3 to 0.6 sec. In three occurrences, this period was roughly the same as the one-hop whistler-mode delay along the field-line path; however, no demonstrable mechanism to explain this association could be found. An explanation of pulsations in terms of multipath fading effects could not be supported by the data. More likely explanations include intrinsic oscillation in the emission generation mechanism, natural oscillation in the energetic-particle population, or modulation of the vlf growth rate by Pc-1 micropulsations in the region of wave growth. (auth)

5344 RADIAL GRADIENT OF GALACTIC PROTONS IN THE INNER SOLAR SYSTEM. Englade, Ronald C. (Air Force Cambridge Research Lab., Bedford, Mass.). J. Geophys. Res.; 76: No. 34, 8394-8400(1 Dec 1971).

Numerical solutions of a realistic particle propagation model for the inner solar system are used to investigate the radial gradient of galactic protons with 50- to 2000-MeV energy. The model assumes anisotropic, energy-dependent diffusion in a stochastic interplanetary magnetic field whose average configuration is the Archimedian spiral pattern, and includes adiabatic deceleration as the dominant energy-change mechanism. The results are compared with the Mariner-4 measurements of the energy-dependent Earth-Mars gradient reported by O'Gallagher, and the possible role of particle transport in the solar colatitude (θ) direction is examined. (auth)

5345 FIELD-ALIGNED PARTICLE CURRENTS NEAR AN AURORAL ARC. Choy, Lawrence W. (Univ. of New Hampshire, Durham); Arnoldy, R. L.; Potter, Wentworth; Kintner, Paul; Cahill, Laurence J. Jr. J. Geophys. Res.; 76: No. 34, 8279-98 (1 Dec 1971).

A Nike-Tomahawk rocket equipped to measure electric and magnetic fields and charged particles from a few eV to several hundred keV energy was flown into an auroral band from Fort Churchill on April 11, 1970. The particle detectors were oriented so as to measure net field-aligned currents. Electrons from a few to several keV were responsible for the auroral luminosity and represented a positive current away from the atmosphere of the order of 5×10^{-7} amp m^{-2}. Changes in the fluxes of these particles are observed to be the cause of luminosity variations. Enhancements in the transverse electric-field magnitude are correlated with auroral motions and increases in the overall luminosity. The $E \times B$ drift imposed on the primary beam can account for auroral motions observed. North of the auroral luminosity, an intense current sheet was measured by the particle detectors. The precipitating electrons responsible for the current sheet had an energy of the order of a few hundred eV and resulted in a field-aligned current about an order of magnitude greater than that produced by the more-energetic electrons responsible for the luminosity. The current sheet separated the region of hard spectra magnetically tied to the aurora from that characterized by soft spectra north of the luminosity. The spectrum of particles north of the aurora was very soft, having a shape and intensity similar to that consistently seen in the tail of the magnetosphere by the Vela spacecraft. The implication of this is that perhaps the northern edge of the luminosity is a line of demarcation beyond which field lines commence to thread the plasma sheet. When intense field-aligned currents were observed, the direction of the electric field in the ionosphere pointed westward or southwestward. Outside of the region of luminosity and when the substorm was recovering, the electric field switched to an eastward direction as the magnitude of the field-aligned currents decreased. This correlation appears to be a spatial effect, although it could be interpreted temporally as a characteristic of magnetosphere-tail fields during the substorm recovery. A correlation of particle fluxes measured by the rocket detectors and those seen simultaneously at 6.6 R_E by the ATS 5 spacecraft is discussed. (auth)

5346 CORRELATED CHANGES BETWEEN THE DAILY VARIATION OF GEOMAGNETIC FIELD AND INTERPLANETARY PLASMA PARAMETERS. Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Geophys. Res.; 76: No. 34, 8199-8210 (1 Dec 1971).

A definition of the daily variation range of the geomagnetic-field H component has been given simply as $\Delta H = H_{max} - H_{min}$. Several characteristics of the daily range and its correlation with interplanetary parameters are reported. It is shown that for disturbed periods this definition is inappropriate and gives faulty estimates of the range owing to Dst pollution. After proper correction for Dst effects, the genuine Sq and Sd were evaluated for several stations in the longitude belt 60 to 80°E for 1964 and particularly for the Imp-1 period (November 27, 1963, to February 15, 1964). The following conclusions were reached. (a) The quiet-day daily variation Sq is a predominantly daytime phenomenon. The day-to-day variability is caused by fluctuations in H_{max} rather than in H_{min}. For equatorial locations, the variation is correlated with E-region apparent drift velocities and the B_z component (southward) of the interplanetary field. For midlatitudes, it is related to B_x and B_y. A very rough estimate indicates about 70% ionospheric and 30% magnetospheric contribution. (b) The disturbance daily variation can be conveniently divided into positive and negative components ΔSd^+ and ΔSd^-. The ΔSd^+ is a morningtime increase from about midnight to 1000 LT and is similar to normal Sq but with flatter latitude dependence. Equatorial ΔSd^+ is related negatively to solar-wind velocity, while midlatitude ΔSd^+ is related positively to plasma number density. The ΔSd^- component has an almost latitude-independent magnitude, develops between 1000 and 1400 LT at the equator and 1000 and 1800 LT at other latitudes, and is slightly negatively correlated with the standard deviation σ_{B_z} of the B_z component. This component seems to be mostly magnetospheric, probably owing to a partial ring current centered in the afternoon-dusk hours. (auth)

5347 HYDROMAGNETIC SURFACE WAVES. Takei, Shigeo (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser.; 21: No. 1, 1-18(Apr 1971).

The hydromagnetic response of a plane of tangential discontinuity in a plasma shows the existence of hydromagnetic surface waves. In addition to the surface wave of the incompressible mode that has been known formerly, it is found that two kinds of the compressible surface waves, called here fast and slow compressible surface waves, can exist. These surface waves propagate in the plane of discontinuity at angular-dependent phase velocities, and their amplitudes decrease exponentially with the distance from the plane. The phase velocity, the group velocity, the attenuation length, and other propagation characteristics of the surface waves are described, based on the result of numerical calculations. (auth)

5348 PHYSICAL STRUCTURE OF HYDROMAGNETIC DISTURBANCES IN THE INNER MAGNETOSHEATH. Kaufmann, Richard L.; Horng, Jiann-tsorng (Univ. of New Hampshire, Durham). J. Geophys. Res.; 76: No. 34, 8189-98(1 Dec 1971).

A physical model of the magnetic-field structure that exists in the inner magnetosheath, near the Earth-Sun line, and during highly disturbed periods is described. Magnetometer data are presented in a new format that uses the ordinary inclination-declination coordinate system. Measurements of the inclination angle show how much the field lines are distorted from being tangent to the magnetopause. Distortions in the inclination angle sometimes exceed 45° in the low-field regions that are believed to be associated with plasma condensations or clouds. The magnetic field is usually within 15° of being tangent to the magnetopause in high-field regions, but some larger distortions have also

been seen here. The clouds usually appear to be extended along the average magnetic-field direction. A characteristic dimension for the observed structures is between several hundred and several thousand kilometers. Some large changes in the declination angle are not directly associated with clouds. These distortions imply that the field structure can rotate and still remain roughly tangent to the magnetopause. The large rotations are probably produced by changes in the solar wind and in the interplanetary magnetic field. Other declination angle changes are associated with clouds and provide evidence that field-aligned currents can be present in the magnetosheath. Several sets of measurements were made very near the Earth–Sun line. Some changes in the wave amplitude and frequency are noted in this region, but these changes can simply be the result of a reduction in the plasma-flow speed. No unexpected effects that require new types of waves or instabilities have been found near the subsolar point. (auth)

5349 RATIO OF SPECIFIC HEATS IN SOLAR-WIND PLASMA FLOW THROUGH EARTH'S BOW SHOCK. Shen, Wen-wu (Durham Technical Inst., N. C.). J. Geophys. Res.; 76: No. 34, 8181-8(1 Dec 1971).

The ratio of specific heats in the solar-wind plasma flow can be significantly different in the upstream and downstream regions of the Earth's bow shock. On the basis of one-fluid theory, the conservation equations of a normal magnetic shock are solved for compressional ratios of fluid parameters. It is found that jump ratios of fluid parameters are sensitively dependent on the ratio of the specific heats only in the downstream region. The appropriate ratio of specific heats of a thermodynamic analog to the reducible problems in the magnetohydrodynamic flow is investigated. This ratio will permit theoretical calculations to include the magnetic field for techniques such as hypersonic analog or inverse method in solving the blunt-body problems. (auth)

5350 ELECTRON ENERGY FLUX IN THE SOLAR WIND. Ogilvie, K. W.; Scudder, J. D.; Sugiura, M. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: No. 34, 8165-73(1 Dec 1971).

Studies of electrons between 10 eV and 9.9 keV in the solar wind were made. The transport of energy in the rest frame of the plasma is evaluated and shown to be parallel to the interplanetary magnetic field. The presence of electrons from solar events causes this energy-flux density $E_\parallel$ to exceed the heat flow $H_\parallel$ due to thermal electrons. In one such event, the observations are shown to be consistent with the solar-electron observations made at higher energies. When observations are made at a point connected to the Earth's bow shock by an interplanetary-field line, a comparatively large energy flux along the field toward the Sun is observed, but $H_\parallel$ remains outwardly directed during this time interval. In either situation $H_\parallel$ is found to be consistent with measurements made on Vela satellites by a different method. These values, less than 1×10^{-2} ergs/cm^2/sec, are sufficiently low to require modifications to the Spitzer–Harm conductivity formula for use in solar-wind theories. (auth)

5351 CHARACTER OF THE CHANGE IN THE POSITION OF THE BOUNDARY OF THE EARTH'S MAGNETOSPHERE, OF THE BOW SHOCK WAVE, OF THE THICKNESS OF THE TRANSITION REGION, AND OF THE MAGNETIC FIELD OF MAGNETOPAUSE CURRENTS DURING GEOMAGNETIC STORMS. Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 2, 270-3(1971).

Translated from Geomagn. Aeron.; 11: No. 2, 325-7(1971).

The geocentric distance to the magnetopause and to the bow shock, the thickness of the transition region at a subpolar point δr_0, and the fields of magnetopause currents at the surface of the Earth during three geomagnetic storms on Sept. 11 and Oct. 7, 1962, and Apr. 17, 1965 are computed from data on solar plasma fluxes and on interplanetary magnetic field. Parameters applying to each storm are described and comparisons are made. (J.C.W.)

Low-Temperature Physics and Cryogenic Equipment

Refer also to abstract 4946.

5352 (COO-1569-81) EXPERIMENTAL AND THEORETICAL STUDIES IN SOLID STATE AND LOW TEMPERATURE PHYSICS. Annual Progress Report, 1971. (Minnesota Univ., Minneapolis. Inst. of Tech.). Sep 1971. Contract AT(11-1)-1569. 59p. Dep. NTIS.

CHROMIUM—effects on NMR spectra of cobalt, satellite
COBALT—nuclear magnetic resonance spectra of, effects of impurities on
COBALT ISOTOPES Co-60—Knight shift in copper–gold system
COPPER ALLOYS—Cu-base–Mn, magnetic saturation of Kondo system
CRYSTALS—theory of quantum, research on
GOLD ALLOYS—Au–Cu, cobalt-60 Knight shift in
HELIUM ISOTOPES He-3—properties of solid, research on quantum
HELIUM ISOTOPES He-4—superfluid flow, research on
MANGANESE—effects on NMR spectra of cobalt, satellite
QUANTUM MECHANICS—research on crystalline helium-3, (T)
SUPERCONDUCTORS—research on pair-field susceptibility and fluctuations in junctions and films
SUPERFLUIDITY—research on circulation quantization and Josephson effect analog in helium
VANADIUM—effects on NMR spectra of cobalt, satellite (D.L.C.)

Superfluidity

5353 (N-71-28122) SUPERCONDUCTING PROPERTIES OF NIOBIUM FILMS. Hudson, Wayne R.; Jirberg, Russell J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1971. 25p. (NASA-TN-D-6380). NTIS.

Critical currents as a function of magnetic field, film thickness, and film orientation were studied for 14 niobium films ranging in thickness from 16.2 to 1153 nm (162 to 11,530 Å). All measurements were made at 4.2°K. Measurements of the critical current with respect to the angle between the surface of the film and the magnetic-field direction revealed that a sharp critical current maximum occurs when the magnetic field is parallel to the film surface. For films thicker than 88.0 nm a broad maximum in the critical current was also observed when the orientation of the magnetic field was nearly perpendicular to the film. Films with a thickness between 25.0 and 60.0 nm carried the highest current densities in large magnetic fields. The ratio of the parallel critical magnetic field to the perpendicular critical magnetic field was less than 1.69 for films where the thickness was much greater than the coherence length. When the thickness was on the order of the coherence length the ratio was greater than 1.69 at 4.2°K. (auth) (STAR)

5354 NOTE ON PHONON LIFETIMES IN He II. Jaeckle, J. (Univ., Geneva); Kehr, K. W. Phys. Lett.; 37A: No. 3, 205-6 (22 Nov 1971).

It is argued that in the well-known expression for the probability of a three-phonon process in He II, it is the wide-angle scattering rate of thermal phonons which should be compared with energy differences. (auth)

5355 NOTE ON BOSE CONDENSATION. Sherrington, D. (Imperial Coll. of Science and Tech., London). Phys. Lett.; 37A: No. 3, 223-4(22 Nov 1971).

A recent paper of Kohn and Sherrington on Bose condensation in Fermi systems and its relation to superfluidity is specialized to systems whose constituents may be considered essentially as true bosons. (auth)

5356 SURFACE TENSION OF ^{3}He–^{4}He MIXTURES. Guo, Hong-ming. Columbus, Ohio; Ohio State Univ. (1971). 150p. University Microfilms Order No. 71-22,483.

Thesis.

The surface tension of dilute solutions of ^{3}He in ^{4}He with concentrations up to 22% and at temperatures down to 0.04K was determined from the capillary rise of the liquid in a parallel plate capacitor. The capacitor gap had different widths above and below a sharp step. The liquid level could be moved up and down by a bellows, and the surface tension was determined from the change in level outside the capacitor needed to raise the meniscus across the step inside the capacitor. The results are consistent with the higher-temperature data of Zinoveva and Boldarev. They also support Andreev's theory in which an adsorbed layer of ^{3}He on the surface acts as an ideal, two-dimensional Fermi gas whose pressure reduces the surface tension. The binding energy, ϵ_0, of the surface quasiparticles was determined to be 2.03 ± 0.06K, while the effective mass varied from ~2.0 to 2.4 m_3 as the concentration of ^{3}He in the bulk liquid was increased from 0 to 10%. The measured results in the vicinity of phase separation confirmed the speculation that the mixture surface may act as a nucleation center for the ^{3}He-rich phase to grow. The upper phase surface tension and the interfacial tension of phase-separated mixtures were also measured. The results indicated that Antonov's rule was followed. The phase separation temperatures were also measured. (Diss. Abstr. Int., B)

5357 STRUCTURE AND NUCLEATION OF QUANTIZED VORTICES IN HELIUM II. Strayer, Donald Melvin. Eugene, Oreg.; Univ. of Oregon (1971). 200p. University Microfilms Order No. 71-23,131.

Thesis.

Motions of helium II and motions of ions in helium II have been studied for many years. It has emerged that a full understanding of these phenomena requires a notion of the structure of quantized vortex lines and how such lines are created. Quantized vortex lines are generated in the laboratory by rotating a container of helium II. Vortex lines were studied in the experiments described here by observing the motion of negative ions localized on the vortex cores. An attempt is made to explain the observations with a simple model which considers the localization of roton excitations near the core. The apparatus consists of an ion time-of-flight apparatus mounted on a rotating table and cooled by a ^{3}He refrigerator. Ions moving through helium II at low velocities obey a simple mobility law. At high velocities, nonlinear effects set in which can be observed over a wide range of temperatures. An explanation of the velocities reported is attempted with a model of roton excitations localized near a moving ion. At sufficiently high velocities, ions are known to generate macroscopic vortex rings which can, under certain conditions, remain bound to the ion. Donnelly and Roberts have tried to explain this ring nucleation by imagining that one of the localized rotons can grow by thermal fluctuations to become a macroscopic vortex ring that is attached to the moving ion. Experiments are reported which tend to confirm this stochastic model. Agreement is excellent at the vapor pressure and qualitatively correct at high pressures. Refinement of the model evidently requires a better understanding of the pressure dependence of ion and helium parameters. (Diss. Abstr. Int., B)

5358 THEORY OF THE SUPERFLUID-SOLID TRANSITION OF ^{4}He. Schneider, T.; Enz, C. P. (IBM Zurich Research Lab.). Phys. Rev. Lett.; 27: No. 18, 1186-8(1 Nov 1971).

The pressure-induced superfluid–solid transition of ^{4}He at T = 0 is investigated. Neglecting the accidental instability against nucleation, one finds a definite stability limit at which the superfluid phase becomes intrinsically unstable against a density fluctuation number Q_L. The roton minimum with frequency $\omega(Q_L)$ is the soft mode associated with this stability limit. This interpretation reflects the observed pressure dependence both of the roton minimum and of the first maximum of the structure factor at Q_L. (auth)

5359 LOW-TEMPERATURE THERMODYNAMIC PROPERTIES OF SUPERFLUID SOLUTIONS OF ^{3}He IN ^{4}He. Ebner, C.; Edwards, D. O. (Ohio State Univ., Columbus). Phys. Rep.; 2C: No. 2, 77-154(Sep 1971).

The low-temperature thermodynamic properties of dilute solutions of ^{3}He in ^{4}He are reviewed. The main emphasis is on experiments and theoretical work performed since the discovery that some ^{3}He remains in solution even at T = 0. The experiments include measurements of the heat capacity, phase separation, equation of state, osmotic pressure, heat of mixing, nuclear magnetic susceptibility and first- and second-sound velocities. The discussion is limited to ^{3}He concentrations below about 15% and temperatures small enough ($T \lesssim 0.6$ K) that the contributions from thermal phonons and rotons are negligible. The dependence of the various properties on temperature, concentration and, where data exist, pressure is described and analyzed in terms of various simple theories of helium solutions. The original theory is that of Landau and Pomeranchuk in which the ^{3}He impurities are supposed to behave as free Fermi excitations of effective mass m where m depends only on the pressure. The "Fermi entropy model," which is useful in the analysis of thermodynamic data at finite temperature, is an empirical generalization of the Landau–Pomeranchuk theory in which the entropy is still given by the ideal Fermi gas formula, but the effective mass is allowed to depend on concentration as well as pressure. The most accurate theory ("dilute solution theory") includes the effects of interactions between ^{3}He excitations, and it is developed here as an expansion of the osmotic energy, $U - N_4\mu_4$, in terms of the ^{3}He quasi-particle distribution function. Various theories of the effective interaction potential and its relation to the transport properties are reviewed. The results of the experiments are compared with the predictions of the theory, based on the most recent conjectures for the interaction potential, only in the limit of $T \to 0$ at zero pressure. The one exception is the normal mass density of the ^{3}He component ρ_n for which the theory is compared with the results of second sound experiments at all temperatures such that the effects of thermal phonons and rotons are negligible. Finally, application of the solution thermodynamics is made to the theory of dilution refrigerators. (auth)

5360 HYDRODYNAMICS OF A SUPERFLUID CONDENSATE. Hyland, G. J.; Rowlands, G. (Univ. of Warwick, Coventry, Eng.). Physica; 54: No. 4, 542-56(30 Sep 1971).

A closed set of hydrodynamic equations involving the macroscopic parameters of the ^{4}He II condensate, rather than those of the superfluid, is derived from the exact quantum-mechanical equation of motion for the first-order reduced density matrix. The method is based on Chapman–Enskog-type expansion about a local equilibrium together with the explicit use of the microscopic symmetry properties of the first- and second-order reduced-density matrices. (auth)

5361 CONSTANT-PRESSURE HEAT CAPACITY OF A BOSE FLUID IMMEDIATELY ABOVE THE λ POINT. Sikora, P. T. (University Coll., Galway, Ireland); Mohling, F. J. Low Temp. Phys.; 5: No. 5, 537-43(Nov 1971).

The heat capacity C_p of a Bose fluid immediately above its λ point is shown to depend solely on the nature of its low-momentum quasi particles. If these quasi particles are only weakly interacting, then it is possible to specify uniquely the limiting behavior $C_p(T \to T_\lambda^+)$ from a knowledge of the quasi-particle energy–momentum relation $\omega'(k)$ in the low-momentum limit. Thus, phonon-type behavior is shown to result in a finite cusp for $C_p(T_\lambda^+)$. The relevance of these results to liquid ^{4}He is discussed. (auth)

5362 MACROSCOPIC QUANTUM EFFECTS IN A LIQUID-HELIUM DROP. Huberman, B. A. (Xerox Palo Alto Research Center, Calif.). Phys. Lett.; 37A: No. 3, 225-6(22 Nov 1971).

It is shown that under certain conditions a small liquid helium drop displays quantum phase coherence throughout its volume. Under these conditions there is a condensation into a state of definite angular momentum that can be measured by macroscopic means. (auth)

5363 ONSET OF TURBULENCE IN THE FLOW OF LIQUID HELIUM II BETWEEN ROTATING CYLINDERS. Devaraj, N. (Bangalore Univ., India). pp 17-23 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

5364 FILM TRANSFER OF HELIUM II FOR LARGE PRESSURE HEADS. Radhakrishnan, T. S.; Rangarajan, S.; Chandra, Girish (Tata Inst. of Fundamental Research, Bombay). pp 25-30 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

5365 TRANSPORT COEFFICIENTS IN LIQUID HELIUM. II. Ichiyanagi, Masakazu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 666-7(Aug 1971).

Previously, the mode–mode coupling theory was applied to the lambda transition of helium. Here, the problem is studied in the framework of the relaxation matrix by Mori. The time-fluctuation expressions for the transport coefficients of liquid helium II are obtained. (M.H.R.)

Superconductivity

5366 (CONF-711027-1) PHONON SPECTRA AND SUPERCONDUCTIVITY IN SOME TRANSITION- AND ACTINIDE-METAL CARBIDES. Smith, Harold G. (Oak Ridge National Lab., Tenn.). [1971]. 18p. Dep. NTIS.

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The phonon dispersion curves were measured by inelastic neutron scattering for the carbides of the transition metals Ta, Hf, Nb, V, and Zr in which unusual features in some of the modes are observed for those compounds that become superconducting, (TaC, NbC), compared to those that do not. Studies immediately above and below the transition temperature in TaC did not reveal any changes in phonon frequency or width. No unusual features are observed in the phonon spectra of the actinide UC, a nonsuperconductor. Although $NbC_{0.76}$ (not superconducting above 1.2°K) does not show the changes in some of the modes seen in $NbC_{0.98}$, some of the phonons are extremely broad and asymmetric. This is possibly related to the highly defect nature of the crystal. These results seem to corroborate McMillan's suggestion for the transition metals, i.e., that the electron–phonon coupling constant, and hence the transition temperature, is very sensitive to the phonon frequencies in the strong-coupled superconductors. (auth)

5367 (COO-1569-85) FLUCTUATION BROADENING OF THE RESISTIVE TRANSITION TO THE SUPERCONDUCTING STATE OF $Nb_{.88}Ti_{.12}N$ THIN FILMS. Schaer, Frederick Michael (Minnesota Univ., Minneapolis). Dec 1971. 175p. Dep. NTIS.

Thesis.

Measurements of resistance of short mean free path $Nb_{.88}Ti_{.12}N$ thin films are reported. Evidence for fluctuation conductivity is found at temperatures at least twice the 11°K transition temperature. In the upper part of the transition, there is qualitative agreement with the fluctuation conductivity calculation by Aslamasov and Larkin. (M.H.R.)

5368 (N-71-34907) STUDY OF THE MECHANISMS OF FLUX PINNING IN TYPE 2 SUPERCONDUCTORS. Final Report. Coffey, H. T.; Chilton, F.; Barbee, T. W. Jr. (Stanford Research Inst., Menlo Park, Calif.). Feb 1971. Contract NAS8-24816. 80p. (NASA-CR-121867). NTIS.

Theoretical and experimental studies were made of the flux pinning mechanisms in Type-II superconductors. A theoretical model based on the London theory was used to obtain trial functions for a variational calculation using the Ginzburg-Landau theory. The microscopic properties of fluxoids were calculated. The model was applied to the problem of flux pinning by large defects having a gradient, small normal regions or voids, and small regions having values different from the bulk of the sample, which seems to be responsible for the peak effect in Type-II superconductors. The forces arising from these pinning mechanisms were related to the critical transport current and were found to provide reasonable approximations to experimental data. Specific heat measurements were made on annealed and deformed pure niobium samples. Tight adhesion of the ferromagnetic power to the sample prevented stripping the power for observation in an electron microscope. (STAR)

5369 (ORO-3665-30) STUDY OF VERY PURE METALS AT LOW TEMPERATURES. Progress Report. (Georgetown Univ., Washington, D. C. Dept. of Physics). [1971]. Contract AT(40-1)-3665. 105p. Dep. NTIS.

ALUMINUM—electron tunneling in superconducting, (E)
ELECTRONS—tunneling in gallium, aluminum, and indium
GALLIUM—electron tunneling in superconducting, (E/T)
—magnetic susceptibility at low temperature, resistive component of ac, (E/T)
GALLIUM ALLOYS—Ga-base-In, superconducting properties of splat-cooled, (E)
INDIUM—electron tunneling in superconducting, (E) (D.L.C.)

5370 ANISOTROPIC UPPER CRITICAL FIELD OF PURE TYPE-II SUPERCONDUCTORS AT LOW TEMPERATURES. Takanaka, Keniji (Tohoku Univ., Sendia). Progr. Theor. Phys. (Kyoto); 46: No. 2, 357-63(Aug 1971).

The upper critical field H_{c2} appropriate for a pure single crystal with an anisotropic Fermi surface is calculated at low temperatures and is found to have a form $H_{c2}(t) = H_{c2}(0) \times (1 + \eta\, t^2 \ln t)$, where $t = T/T_c$. Coefficients $H_{c2}(0)$ and η are anisotropic, reflecting the Fermi surface anisotropy. This expression is a generalization of that for a spherical Fermi surface given by Gor'kov for an anisotropic case. (auth)

5371 NONMONOTONIC RELATION BETWEEN THE SUPERCONDUCTING TRANSITION TEMPERATURE AND THE ELECTRON CONCENTRATION. Golovashkin, A. I.; Motulevich, G. P. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 1029-30(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1232-4(Apr 1971).

The correlation between the conduction electron concentration N, average electron velocity at the Fermi surface V_F, and total area of the Fermi surface S_F and the superconducting transition temperature T_c is examined for Nb and four alloy systems (Nb-Ti, V-Ga, Nb-Sn, and $SrTiO_3$). A nonmonotonic (having a maximum) relation is observed for each of the alloy systems. It is suggested that a small drop in N_{max} (N at highest T_c) below 0.7×10^{22} cm^{-3} for Nb-Sn might lead to a further increase in T_c. (D.L.C.)

5372 OBSERVATION OF CYLINDRICAL CAVITY MODES IN CIRCULAR JOSEPHSON WEAK-LINK JUNCTIONS. Bermon, Stuart; Mesak, R. M. (Brown Univ., Providence). J. Appl. Phys.; 42: No. 11, 4488-92(Oct 1971).

The observation of self-induced step structure in the I-V characteristic of bulk-Hg/C/Sn multiple weak-link Josephson junctions formed by freezing a small drop of mercury onto the surface of a carbon covered tin film is reported. The voltages at which steps appear are found to correspond to the frequencies of the resonant modes of the open-sided cylindrical rf cavity formed by the circular bottom of the mercury drop and the tin film. The effect of temperature and applied magnetic field on the junction critical current and on the step behavior is explored. The observation of such cylindrical cavity modes is contrasted with the situation for rectangular Josephson junctions where only the strip-line resonances were observed. (auth)

5373 DESIGN PROBLEMS OF SUPERCONDUCTING COMPOSITES. Critchlow, P. R. (Air Reduction Co., Inc., Murray Hill, N. J.). J. Appl. Phys.; 42: No. 11, 4506-8(Oct 1971).

Magnetization measurements are reported on a multifilimentary superconducting composite having a copper-cupronickel matrix. The data show that the function of the cupronickel, to reduce transverse currents, is largely nullified by the presence of the copper in a simple composite having cupronickel between filaments with an outer copper sheath. (auth)

5374 ANOMALOUS ULTRASONIC ATTENUATION IN PURE SUPERCONDUCTING Nb. Lacy, Lewis L. (Marshall Space Flight Center, Huntsville, Ala); Daniel, A. C. Phys. Rev. Lett.; 27: No. 17, 1128-31(25 Oct 1971).

Anomalous ultrasonic attenuation was observed in pure superconducting Nb[100] for $ql_e \approx 1$. The anomalous behavior is believed to be associated with the high purity of the sample, which had a measured resistivity ratio of 6500. The attenuation data were analyzed by assuming that the material has two energy gaps, one with a standard BCS value of $2\Delta_1(0)/kT_c = 3.4$ and the other with $2\Delta_2(0)/kT_c = 10$. (auth)

5375 PREPARATION OF A SUPERCONDUCTING SCANDIUM-CARBON PHASE. Krikorian, Nerses H.; Giorgi, Angelo L.; Szklarz, Eugene G.; Krupka, Milton C. (to United States Atomic Energy Commission). U. S. Patent 3,607,056. 21 Sep 1971. Filed 7 Oct 1969.

A method of preparing a superconducting bcc scandium-carbide phase having the approximate composition $Sc_{13}C_{10}$ is described, which comprises arc-melting scandium and carbon in the presence of small quantities of germanium and then annealing at temperatures above 1,000° and below 1,600°C. (auth)

5376 SUPERCONDUCTING ISOTOPE EFFECT IN ZrB_{12}. Fisk, Z. (Bell Telephone Labs., Inc., Murray Hill, N. J. Univ of Chicago); Lawson, A. C.; Matthias, B. T.; Corenzwit, E. Phys. Lett.; 37A: No. 3, 251-2(22 Nov 1971).

The Zr isotope effect appears to be much stronger in ZrB_{12} than in elemental Zr (the B isotope effect in ZrB_{12} is known to be small). The superconductivity of ZrB_{12} is apparently caused by optical phonon modes associated with the internal motion of Zr atoms inside boron cages. (auth)

5377 FLUCTUATION CORRECTIONS TO THE LANDAU THEORY OF PHASE TRANSITIONS. Marcelja, Stjepan. Rochester, N. Y.; Univ. of Rochester (1971). 99p. University Microfilms Order No. 71-22,306.

Thesis.

A new method is presented for including the effects of fluctuations in the Landau theory of second-order phase transitions. As the system approaches the phase transition point from higher temperatures, the fluctuations in the order parameter become increasingly important. Close to the critical point, interaction between the fluctuations may not be neglected. The effects of this interaction are included in a self-consistent first-order perturbation theory, and solutions are obtained for a number of properties such as average density of the order parameter, specific heat, and magnetic susceptibility. The electrical conductivity at the superconducting phase transition, as predicted by the corrected theory, was examined in detail. In the region below the uncorrected critical point, the theory predicts an exponential dependence of conductivity on the temperature in two dimensions and a cubic dependence in one dimension. The results of experiments performed on thin films and whiskers are in a very good agreement with the expected behavior. The relation between the present calculation based on the phenomenological Landau theory and the microscopic theory of superconductivity was established. This, in turn, made possible the more general examination of the applied approximation. The higher orders in the perturbation theoretic series were examined, and the rigorous criteria for the validity of the developed approximation are stated. Within the microscopic theory of the superconducting transition, the expression for the Copper pair propagator above the transition point and starting from there, the correction to the electron's Green function were obtained. The resulting Green's function can be used to calculate the electronic properties at the superconducting transition, and it was applied to determine the density of electronic states as a function of temperature. (Diss. Abstr. Int., B)

5378 COMPARISON OF MICROWAVE-INDUCED CONSTANT-VOLTAGE STEPS IN WEAKLY COUPLED SUPERCONDUCTORS. Bracken, Thomas Daniel. Stanford, Calif.; Stanford Univ. (1971). 128p. University Microfilms Order No. 71-23,489.

Thesis.

The Josephson voltage-frequency relationship $h\nu = 2$ eV relates

the frequency ν of the ac supercurrent between two weakly coupled superconductors, when they are biased at a dc voltage V. If microwave radiation of frequency ν is incident on a weakly coupled structure, such as a thin film tunnel junction, constant voltage steps at $V = (nh\nu/2e)$ are induced in the dc current–voltage characteristic. These steps correspond to the zero beat between the applied fields and the ac supercurrents. Absolute voltage measurements on these steps yielded a value of 2e/h accurate to 2.2 ppm. The accuracy and reproducibility of these results prompted a readjustment of the fundamental constants and a proposal to redefine the volt in terms of the Josephson relationship. In the experiment described here, the value of 2e/h is compared in different materials at the .001 ppm level by making a differential measurement of the corresponding voltage steps in two different junctions. (TSS) (Diss. Abstr. Int., B)

5379 THERMOMAGNETIC EFFECTS IN NORMAL AND SUPER-CONDUCTING INDIUM AND NIOBIUM. Stephan, Craig Hammann. Ithaca, N. Y.; Cornell Univ. (1971). 118p. University Microfilms Order No. 71-25,170.
Thesis.

Measurements of the Hall effect and its thermal analog, the Righi–Leduc effect, and of the thermal magnetoresistance, in indium and niobium are reported. The behavior of the Hall and Righi–Leduc effects in strong magnetic fields is presented. Measurements of these two effects were made in the same polycrystalline indium plates at temperatures between 2.5 and 8°K. It was found that a generalized Wiedemann–Franz law is obeyed at high fields, even though scattering of electrons is predominately inelastic. Detailed measurements of the Righi–Leduc coefficient in oriented single-crystal specimens of indium in weak magnetic fields are described. It is found that the coefficient reverses sign as the magnetic field is increased from zero. The value of this crossing field varies with temperature as T^2. Preliminary results are reported of calculations, based on this data, of the ratio of relaxation times of the third zone electron-like carriers to the second zone holes. These calculations indicate a ratio of about 1.2. Measurements of the Righi–Leduc coefficient and the thermal resistance of metals in the superconducting state are presented. In the mixed state of niobium, a Type-II superconductor, the thermal resistance exhibits a maximum near H_{cl} and then decreases sharply at H_{c2}, as expected from theoretical considerations and observations of other experiments. The ratio of the transverse to the longitudinal temperature gradient is nearly constant for magnetic fields between 0.2 and 0.8 H_{c2}, but at a value much smaller than the normal-state value at H_{c2}. There is a sharp change just below the upper critical field. No unusual behavior is observed in the normal state. Measurements in the intermediate state of (polycrystalline) indium, a Type-I superconductor, give the expected results for the behavior of the thermal resistance. Preliminary measurements of the Righi–Leduc effect indicate that a sign reversal occurs at magnetic field values consistent with the results described. (Diss. Abstr. Int., B)

5380 MAGNETIZATION OF SUPERCONDUCTING RHENIUM. Wells, Charles Allie. Houston, Tex.; Rice Univ. (1971). 79p. University Microfilms Order No. 71-26,373.
Thesis.

The properties of superconducting rhenium close to the critical temperature were studied. A method of obtaining the magnetization curve of a superconductor was developed, using a closed superconducting loop with feedback proportional to the magnetization. With this method, magnetization curves were obtained for temperatures for which $(T_c - T)$ is less than 2×10^{-2}°K. For the zone-refined rhenium sample used, a value of $T_c = 1.6955 \pm .003$°K was found. The critical field versus temperature curve was obtained for values of critical field between 0.03 and 3.0 gauss. A value of 204 G/°K was obtained for $dH_c/dT)_{T_c}$. By using Rutgers formula $\Delta C = [VT_c/4\pi\ (dH_c/dT)^2_{T=T_c}]$ which predicts a discontinuity in the specific heat at T_c, it can be said that there is no sign of a logarithmic singularity for $(T_c - T) > 5 \times 10^{-4}$°K. It was not possible to identify any effects due to fluctuations close to T_c. Measurements of the critical field close to T_c were limited by the transition width of the magnetization curves. An anisotropy in the rhenium sample was found. A minimum in the transition width was discovered for a specific orientation when the sample was rotated about its axis. This variation in transition width can be explained by a change in the angle of the applied magnetic field relative to slip planes in the sample. When the magnetic field is perpendicular to superconducting filaments composed of dislocations located in the slip planes, the transition width is less than when the field is parallel. A dependence of this effect on penetration depth causes an increase in the transition width as T approaches T_c. (Diss. Abstr. Int., B)

5381 ELECTRON MICROSCOPY AND DIFFRACTION OF LAYERED, SUPERCONDUCTING INTERCALATION COMPLEXES. Fernandex-Moran, H.; Ohstuki, Mitsuo; Hibino, Akemi; Hough, Charles (Univ. of Chicago). Science; 174: No. 4008, 498-500 (Oct 1971).

Several layered, transition metal dichalcogenide intercalation complexes with unique superconducting properties were examined by high-resolution electron microscopy and electron diffraction. Details of the crystalline lattice and of the lattice imperfections were directly resolved. The results can be correlated with the available x-ray diffraction and chemical data, and they confirm and extend the postulated models. (auth)

5382 SURFACE IMPEDANCE THEORY FOR SUPERCONDUCTORS IN LARGE STATIC MAGNETIC FIELDS. Sherman, Richard David. Pasadena, Calif.; California Inst. of Tech. (1971). 102p. University Microfilms Order No. 71-21,902.
Thesis.

A theory of electromagnetic absorption is presented to explain the changes in surface impedance for Pippard superconductors ($\xi_0 \gg \lambda$) due to large static magnetic fields. The static magnetic field penetrating the metal near the surface induces a momentum-dependent potential in Bogolyubov's equations. Such a potential modifies a quasi-particle's wave function and excitation spectrum. These changes affect the behavior of the surface impedance in a way that in large measure agrees with available observations. (Diss. Abstr. Int., B)

5383 THEORY OF STIMULATED RADIATIVE EMISSION FROM SUPERCONDUCTORS. Bostock, Judith Louise. Washington, D. C.; Georgetown Univ. (1971). 173p. University Microfilms Order No. 71-23,409.
Thesis.

A method for producing stimulated emission in superconductors is proposed. The model for this process is analogous to that used to describe semiconductor injection lasers. Preliminary calculations indicate that for certain materials conditions for lasing are favorable. General criteria for lasing, based on the fact that a current flow in a superconductor depresses or even completely destroys the energy gap, are established, and the results of calculations for several materials are presented. To evaluate these effects, a method was devised for determining the effective interaction parameter of a superconductor as a function of temperature. The method is then applied to the materials aluminum, vanadium, tantalum, niobium, and lead. Finally, a self-consistent procedure for determining the threshold current density and lasing energy of the superconductor is presented. The results of the self-consistent calculation of these parameters are given for Ta, Al, V and Pb. For Ta this model predicts lasing over almost the entire interval of temperature $0 < T < T_c$ and for free space wavelengths of approximately .9 to 5.1 mm. The other materials, however, have regions of nonlasing both with respect to temperature and wavelength. Details of the possible geometry of the cavity for this model are discussed in the weak- and strong-injection limits (thermal electrons in the upper quasi-particle levels of the superconductor much more, and much less, numerous than injected electrons, respectively). A brief discussion of the essential physics that must be included in a more rigorous calculation is also presented. (Diss. Abstr. Int., B)

5384 RESISTANCE PEAK AT THE SUPERCONDUCTING TRANSITION OF THIN FILMS OF TIN AND INDIUM. Ems, S. C.; Swihart, J. C. (Indiana Univ., Bloomington). Phys. Lett.; 37A: No. 3, 255-6(22 Nov 1971).

A narrow resistance peak as a function of temperature and magnetic field was found at the superconducting transition for thin films of tin and indium. The effect is greatest for film thicknesses near the coherence length. (auth)

5385 INTERACTION ENERGY OF FLUX LINES WITH OSCILLATING ORDER PARAMETER. Kraegeloh, U. (Max-Planck-Institut fuer Metalforschung, Stuttgart). Phys. Lett.; 37A: No. 3, 215-16(22 Nov 1971).

Using Kramer's method it is shown that the interaction energy of flux lines with oscillating order parameter may yield stable lattice configurations as observed in the intermediate mixed state. (auth)

5386 GEOMETRIC ARRANGEMENTS FOR MAXIMIZING POWER-TRANSMISSION CAPABILITY IN SUPERCONDUCTING TRANSMISSION CABLES. Guthrie, G. L. (WADCO Corp., Richland, Wash.). J. Appl. Phys.; 42: No. 13, 5719-26(Dec 1971).

An analysis is given of the power carrying capability of several geometric arrangements of superconducting transmission cables for use in dc, single-phase ac, and three-phase ac applications. The integrated Poynting vector is maximized with respect to internal geometric variations under the restric-

tions that E and H remain below fixed maximum values. The discussion includes calculations of maximum energy densities for several three-phase ac geometric arrangements. For a Type-I material, the single-phase or dc energy density achievable with optimized multiple concentric cylinders is found to be approximately three times that available by an intermixed wire geometry using the same materials. A theoretical upper limit is given for the energy per cm^2 which may be sent down a superconducting cable of given Type-I material and given dielectric, independent of the geometry adopted. It is shown that attempts to use flux-canceling geometries to uniformly reduce H are based on misconceptions of the nature of the problem, for both Type-I and Type-II lines. Use of fine filaments of Type-II material to counterlace currents and reduce H are found to be of negative benefit. For niobium ac lines, the dielectric is found to be the limiting material when helium is used as the dielectric. (auth)

5387 ENHANCED SUPERCONDUCTING T_c AND STRUCTURAL TRANSFORMATION IN Mo–Re ALLOYS. Testardi, L. R.; Hauser, J. J.; Read, M. H. (Bell Labs., Murray Hill, N. J.). Solid State Commun.; 9: No. 21, 1829-31(1 Nov 1971).

The superconducting T_c of sputtered Mo–Re films peaks sharply to ~15°K for deposition temperatures approaching the boundary of the σ phase with the mixture of the A12 (α-Mn structure) and Mo phases. X-ray data are used to relate the enhanced T_c and the structural instability. (auth) (UK)

5388 NEW SUPERCONDUCTORS. Geballe, T. H. Sci. Amer.; 225: No. 5, 22-33(Nov 1971).

Some recent research that has led to discovery of a number of promising new superconductors is described. These materials include an alloy that remains superconducting at temperatures about 20°K. In addition, a new class of layered materials incorporating intermetallic compounds and organic molecules were found to be the most anisotropic, or directional, superconductors produced to date. The largely empirical approach employed to make these discoveries has in turn yielded new insights into the basic structural and chemical conditions favorable for the occurrence of superconductivity and, in particular, for the attainment of high superconducting transition temperatures. (M.H.R.)

5389 COMPARISON BETWEEN FERROMAGNETISM AND SUPERCONDUCTIVITY OF INTERCALATION COMPOUNDS. Matthias, B. T. (Bell Telephone Labs., Murray Hill, N. J. Univ. of California, San Diego, La Jolla). Phys. Lett.; 37A: No. 3, 249-50(22 Nov 1971).

A comparison between the ferromagnetism and superconductivity of graphite intercalation compounds suggests the absence of either phase transition in a two-dimensional array. (auth)

5390 SUPERCONDUCTING ORDER PARAMETER MEASUREMENTS. Rose, Donald Karl. Stanford, Calif.; Stanford Univ. (1971). 58p. University Microfilms Order No. 71-23,552.

Thesis.

This experiment was conducted to investigate the properties of superconducting thin films in the neighborhood of the current and thermal transitions. The density of superconducting charge carriers in the region of interest was observed by measuring the charge-carrier-limited reactive conductivity. The two-fluid model of superconductivity predicts that this conductivity is proportional to the superconducting electron density or what is called the order parameter. This conductivity for filamentary samples is the same as that observed for an inductance. The data show that the two-fluid model and the Landau–Ginzburg theory are adequate representations of the superconducting state. The reactive conductivity shows the $1-(T/T_c)^4$ dependence at low temperatures and the correct limiting form, $1-T/T_c$, near the transition. However, a deviation in the direction of a larger conductivity and hence, order parameter, is observed very close to T_c. This effect is attributed to fluctuations. At temperatures sufficiently close to the transition, the superconducting condensation energy becomes comparable to thermal energies. Using the Ginzburg criterion, a simple model is proposed which explains the effect quite well. The order parameter was measured as a function of current. The data agreed well with the Landau–Ginzburg theory, which predicts a small decrease in the order parameter when a current is flowing. The size of the effect is an excellent measure of the true depairing current density. The critical current density measured in this fashion agrees well with BCS calculations. (TSS) (Diss. Abstr. Int., B)

5391 ANISOTROPY OF SURFACE CRITICAL CURRENT IN SUPERCONDUCTING NIOBIUM CRYSTALS. Das Gupta, Amit. Ithaca, N. Y.; Cornell Univ. (1971). 117p. (NYD–4060-7). University Microfilms Order No. 71-27,379.

Thesis.

Anisotropy of the extrapolated critical current density J_F is observed if the angle ϕ between the applied magnetic field H and the surface of the niobium single crystal is varied. The experimental data at high ϕ and high H can be represented by the following equations $J_{F_i}^2 = \alpha/\sin(\phi+\gamma-\xi)$ and $J_{F_\theta}^2 = \alpha/\sin(\phi-\gamma-\xi)$, where $J_{F_i}^2$ and $J_{F_\theta}^2$ are the surface critical currents when the Lorentz force on the fluxoids are into or out of the surface, respectively. In a deformed crystal, α increases in direct proportion to the dislocation density threading the surface. Decreasing the magnetic field below H_{c_2} also produces a substantial increase in α. For all ϕ's at high H, J_{F_θ} is found to be greater than J_{F_i}. This normal rectification reverses at small ϕ and low H. Aging in annealed crystal in air at room temperature increases J_F by increasing α. These experimental results indicate that the primary pinning centers of fluxoids near the surface are crystal defects. The observations can be interpreted in terms of Yamafuji–Irie theory, which considers the interaction between a fluxoid and a pin in a region of depth λ below the surface, where the effectiveness of pinning is enhanced through the elastic softening of the fluxoid lattice. Rectification reversal can be explained by the onset of a process of pin escape by fluxoid bowing at low H, the process being favored by the less-repulsive Bean–Livingston potential at these fields. (Diss. Abstr. Int., B)

5392 INTERCALATION COMPLEXES OF LEWIS BASES AND LAYERED SULFIDES: A LARGE CLASS OF NEW SUPERCONDUCTORS. Gamble, F. R. (Syva Research Inst., Palo Alto, Calif.);Osiecki, J. H.; Cais, M.; (and others). Science; 174: No. 4008, 493-7(29 Oct 1971).

Exploration of the generality of the recently discovered reaction whereby certain organic molecules can be inserted between the metallic layers of the superconductors tantalum disulfide and niobium disulfide revealed that a large variety of organic and inorganic molecules can penetrate between the crystalline layers of a number of transition metal dichalcogenides and that the resulting complexes are superconducting if the layered chalcogenide from which they are formed is superconducting. The critical temperatures of the 50 new superconductors reported depend on the nature of the intercalate but are insensitive to a separation of the superconducting planes of up to 57 angstroms. (auth)

5393 SUPERCONDUCTING MATERIALS, 1970. Conrad, Paul. Chemical Process Reviews. Park Ridge, N. J.; Noyes Data Corporation (1970). 149p. $35.00.

Techniques for producing superconducting materials are presented, based on the U. S. Patent literature since 1960. The Table of Contents serves as a subject index. Inventor, patent number, and company indexes are provided. (M.H.R.)

5394 STUDIES OF THIN FILMS OF Nb_3Sn ON Nb. Dickey, J. M.; Strongin, Myron; Kammerer, O. F. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 42: No. 13, 5808-20(Dec 1971).

Experiments are described where thin layers of Sn about 100 Å thick are deposited on Nb surfaces and are then reacted to form Nb_3Sn. An apparatus was developed where the Nb_3Sn can be made and its T_c measured in situ with ambient pressures in the low 10^{-8}-Torr range. Using this apparatus, the progressive conversion of films of Sn on Nb to Nb_3Sn was studied as a function of various parameters such as reaction temperature, thickness, and reaction time. A discussion is given of some of the film properties, and estimates were made of the Nb_3Sn coherence length from the proximity effect between the Nb_3Sn layers and the bulk Nb underneath. (auth)

5395 ALTERNATING CURRENT LOSSES OF STABILIZED NbN. Deis, D. W.; Gavaler, J. R.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys.; 42: No. 13, 5710-12(Dec 1971).

The ac losses of thin films of NbN were measured on uncoated samples and samples coated with copper and aluminum. The reversibility of the superconducting to normal transition was studied under conditions of swept current at fixed field and swept field at fixed current. It was observed that stabilized NbN has ac losses significantly lower than those in the equivalent unstabilized material. (auth)

5396 DYNAMIC STRUCTURE OF VORTICES IN SUPERCONDUCTORS. Thompson, R. S.; Hu, C.-R. (Univ. of Southern California, Los Angeles). Phys. Rev. Lett.; 27: No. 20, 1352-5(15 Nov 1971).

A complete set of time-dependent Ginzburg–Landau equations are solved to find the current, charge, and field distributions when the vortices in a superconductor are forced into motion by a transport current. One finds that, in general, the local electric field is not proportional to the local magnetic field and backflow is an essential feature. (auth)

5397 FLUCTUATION-INDUCED CONDUCTIVITY OF A ONE-DIMENSIONAL, NEARLY IDEAL BCS SUPERCONDUCTOR. Thomas, G. A.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 27: No. 19, 1276-9(8 Nov 1971).

Detailed measurements are reported of the fluctuation conductivity above T_c of one-dimensional aluminum microstrips. These results support a new theory by Patton that apparently resolves the recent puzzle concerning the anomalous contribution to the fluctuation conductivity reported by Maki and Thompson. Comparison of experiment with theory indicates that the samples studied are the first characterized by lifetime effects closely approaching the intrinsic limit for a BCS superconductor. (auth)

5398 SUPERCONDUCTING BERYLLIUM FILMS. Glover III, Rolfe E. (Univ. of Maryland, College Park); Moser, Stefan; Baumann, Friedhold. J. Low Temp. Phys.; 5: No. 5, 519-36 (Nov 1971).

Resistance-vs.-temperature measurements were made on a series of beryllium films condensed on liquid-helium cooled surfaces. Two vapor sources designed to reduce contamination were used and films were prepared on both crystalline quartz and glass substrates. The samples were superconducting with a transition temperature of $T_c = 9.6 \pm 0.1$ K, as indicated by a sharp falloff of resistance on cooling. This qualitatively confirms earlier reports of the superconductivity of quenched beryllium films. The transition curves were, however, appreciably sharper and the transition temperature about a degree higher than previously reported. Good agreement found from sample to sample indicates that the residual impurity concentration was small enough to be unimportant and that the observed transition temperature is characteristic of pure beryllium. The phase of beryllium responsible for the high T_c value disappeared on annealing in the range 40 to 60 K. No indication was found of a reported $T_c \approx$ 6K phase. Beryllium films thicker than about 750 Å broke up during deposition, indicating the presence of large stresses. (auth)

5399 ELECTRONIC SPECIFIC HEAT AND SUPERCONDUCTIVITY STUDIES OF GROUP-V TRANSITION METALS AND CARBIDES. Ishikawa, Masayasu. Minneapolis; Univ. of Minnesota (1971). 100p. University Microfilms Order No. 71-22,213. Thesis.

Low-temperature specific heats of V–Nb alloys and vanadium carbides, and the room-temperature magnetic susceptibilities of vanadium carbides were measured. The superconducting behavior of V–Nb and Nb–Ta alloys was analyzed by means of the strong-coupling theories of McMillan and Hopfield. With the McMillan's theory, the electron–phonon interaction parameter was calculated as a function of alloy composition. According to this analysis, the broad minimum in T_c with alloy composition in the V–Nb system was explained as a rapid weakening of the electron–phonon interaction. In the Nb–Ta system, the electron–phonon interaction parameter was found to vary linearly with composition, as do many other physical quantities. The mass enhancement due to the electron–phonon interaction in these alloys was found to be 1.6 to 1.8. This enhancement dominates the one due to spin fluctuation in these alloys. The Coulomb pseudopotential parameter was found to be very close to 0.13 as suggested by McMillan. The Hopfield theory was also applied to these alloy systems, but it incorrectly predicted the T_c behavior of the V–Nb alloys; it predicted a maximum instead of an experimentally observed minimum in T_c. It was also found that the Hopfield theory fails to predict the correct T_c behavior for V–Mo and V–Ta systems. In the course of this work, an empirical relationship between the electron–phonon interaction parameter and the electronic specific heat coefficient was found and used to predict the superconducting transition temperatures of some elements and alloys. The agreement between the calculated and experimental values of T_c was generally good. The electronic structure of vanadium carbide is also discussed with the aid of magnetic susceptibility and NMR data. (Diss. Abstr. Int., B)

5400 VARIATION OF TRANSITION TEMPERATURE AND SUPERCONDUCTING-STATE PARAMETERS WITH PRESSURE IN TIN. Rajput, J. S. (Banaras Hindu Univ., India). pp 1-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

The three superconducting state parameters (phonon-mediated attractive electron–electron interaction, Coulomb pseudopotential, and quasi-particle renormalization parameter) are evaluated for tin, using 1.75 as the electronic Grueneisen constant. (D.L.C.)

5401 BOUND STATES DUE TO A MAGNETIC IMPURITY IN A SUPERCONDUCTOR. I. Nagaoka, Yosuke; Matsuura, Tamifusa (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 2, 364-86(Aug 1971).

Bound states due to a magnetic impurity in a superconductor are investigated by the Yosida theory using the Green's-function formalism of Nakajima. Calculations are a straightforward generalization of a previous work by Soda and the authors. Results of the present work are qualitatively the same as those obtained in the previous one: if the exchange interaction between the impurity and conduction electrons is ferromagnetic, the ground state is doublet and a discrete triplet state appears within the energy gap; if it is antiferromagnetic and weak compared with the superconducting electron–electron interaction, the ground state is doublet and a discrete singlet state appears; finally, if it is antiferromagnetic and strong, the ground state is a singlet bound state. Results are discussed in comparison with the works by Zittartz and Mueller–Hartmann and by Sato and Maki. (auth)

5402 DISLOCATION EFFECT IN MEASUREMENT OF ENERGY GAP IN SUPERCONDUCTORS BY ULTRASONIC METHODS. Basu, B. K. (Tata Inst. of Fundamental Research, Bombay). pp 5-10 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

The results of Fate et al. (Phys. Rev., 172: 413 (1968)) on the ultrasonic attenuation ratio in superconducting and normal lead are examined from the viewpoint of background attenuation due to dislocations. The corrected data agree with the BCS energy gap of 4.3 kT_c. The ratio B_n/B_I (damping constants in normal state due to electrons and defects, respectively) is taken to be 1.8. If a dislocation density is 10^7 lines/cm^2, $B_n \simeq 10^{-4}$ dynes-sec/cm^2, in agreement with experiment. A small amount of Au diffused through dislocations reduces the altenuation considerably. (D.L.C.)

5403 LINE SHAPE OF JOSEPHSON RADIATION. Sundaram, R.; Bhide, V. G. (National Physical Lab., New Delhi). pp 11-15 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

A calculation is made of the linewidth of the electromagnetic radiation associated with the ac current predicted by Josephson in a superconducting tunnel junction. A Fourier transform of the correlation function is used. It is shown that there will be narrowing of the Lorentzian line. (D.L.C.)

5404 LOCALIZED SPIN FLUCTUATIONS IN SUPERCONDUCTING ALLOYS. Rivier, N. Y.; MacLaughlin, D. E. (Imperial Coll. of Science and Tech., London). J. Phys., F (London): 1: No. 5, L48-52(Sep 1971).

Passage from the nonmagnetic to the magnetic régime in superconducting alloys is treated on a localized spin-fluctuation model. A single phenomenological parameter, the spin fluctuation rate, characterizes both the degree of impurity magnetization and the effect of alloying on superconductivity. The results agree with previous treatments in both the nonmagnetic and magnetic limits. (auth) (UK)

5405 EFFEKT DZHOZEFSONA V SVERKHPROVODYASHCHIKH TUNNEL'NYKH STRUKTURAKH. (Josephson Effect in Superconducting Tunnel Structures). Kulik, I. O.; Yanson, I. K. Sovremennye Problemy Fiziki. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1970). 272p.

The three major topics considered are the theory of the Josephson effect and experimental investigation of the Josephson stationary and nonstationary currents, respectively. The volt–ampere characteristics of the effect and the one-dimensional eddy structures are discussed. Problems of quantum interference in connection with the Josephson effect are explored. Methods of preparing tunnel contacts, the application of the effect in physical experimentation, the properties of Josephson electromagnetic radiation and interaction with exterior electromagnetic radiation are included. 167 references. (tr-auth)

5406 FLUCTUATION THEORY OF THE SUPERCONDUCTING TRANSITION IN RESTRICTED DIMENSIONALITY. Patton, Bruce R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 27: No. 19, 1273-6(8 Nov 1971).

The results of a calculation of the properties of a dirty superconductor near the transition temperature are described. The density of states and conductivity are obtained within an approximation that corresponds to BCS theory above T_c. In two dimensions or less no singularity is encountered at T_c; instead, the conventional BCS results are obtained for $T \ll T_c$, even though the order parameter is strictly zero. The anomalous contribution to the conductivity reported by Maki is found to be well-behaved and finite in the absence of external pair breaking. (auth)

5407 REGULARIZATION OF THE MAKI CONDUCTIVITY BY FLUCTUATIONS. Keller, Joachim; Korenman, Victor (Univ. of Maryland, College Park). Phys. Rev. Lett.; 27: No. 19, 1270-3(8 Nov 1971).

The Maki conductivity for a superconductor above T_c is regularized by taking account of fluctuation effects in the impurity vertex correction. (auth)

5408 TEMPERATURE DEPENDENCE OF ANOMALOUS SUPERCONDUCTING NUCLEATION FIELDS IN ROLLED NIOBIUM FOILS. Ward, R.; Tilley, D. R. (Univ. of Essex, Colchester, Eng.). J. Phys., F (London): 1: No. 5, 667-78(Sep 1971).

The critical fields (H_{c2}) of rolled niobium foils were determined by ac susceptibility and by critical current measurements in parallel and perpendicular fields ($H_{s||}$ and $H_{s\perp}$). H_{c2} agrees with GLAG theory. H_s/H_{c2} increases from a constant value near T_c to a higher constant value at lower temperatures. $H_{s||}$ and $H_{s\perp}$ are attributed to high-κ regions at the surface and in the bulk respectively. It is assumed that the temperature dependence is governed by the ratio $d/\xi(T)$, where d is a characteristic thickness of the high-κ structure. For the internal structure d is estimated to be ~1000 Å, in agreement with the wall thickness of the dislocation cell structure. Assuming that the internal high-κ regions are cell walls, the dislocation density N_D in the walls is estimated as $N_D < 7 \times 10^{11}$ cm^{-2}, in agreement with previous published estimates. (auth)

5409 CHANGE OF THE TRANSITION TEMPERATURE OF ORDINARY SUPERCONDUCTORS. Kresin, V. Z. (Moscow State Pedogogical Correspondence Inst.). J. Low Temp. Phys.; 5: No. 5, 565-74(Nov 1971).

An expression, valid under an arbitrary phonon dispersion law $\omega(q)$, is analytically derived for the critical temperature of ordinary superconductors with weak coupling. The critical temperature T_c turns out to be strongly dependent on the nature of the phonon spectrum. The effect of the dispersion law $\omega(q)$ on the dependence of T_c, on the electron concentration n is investigated. The existence of a maximum of the function $T_c(n)$ is shown to be a possibility. The likelihood of observing nonphonon mechanisms of superconductivity is discussed. (auth)

5410 INFLUENCE OF SUPERCONDUCTING TRANSITION ON INTERNAL FRICTION OF TANTALUM AND NIOBIUM. Zolotukhin, I. V.; Miloshenko, V. E.; Postnikov, V. S. (Voronezh Polytechnic Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 1048-9(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1250-1(Apr 1971).

The internal friction of tantalum and niobium of 99.9 and 99.8% purity, respectively, was measured on equipment with low apparatus losses. The function is shown for tantalum and niobium annealed at 1500°C and with 94.5% and 99.9% deformation, respectively. (M.H.R.)

5411 PUNCHTHROUGH AND THE TUNNELING CRYOTRON. Fulton, T. A. (Bell Telephone Labs., Murray Hill, N. J.). Appl. Phys. Lett.; 19: No. 9, 311-13(1 Nov 1971).

The effect of junction capacitance on the behavior of the Josephson tunneling cryotron is considered, and certain problems that may arise in high-speed applications are described. (auth)

5412 ALTERNATING CURRENT LOSSES IN THIN FILM SUPERCONDUCTORS: NEW CALORIMETRIC MEASUREMENT TECHNIQUE. Meyer, C. H. Jr.; Snowden, D. P.; Sterling, S. A. (Gulf General Atomic Co., San Diego, Calif.). Rev. Sci. Instrum.; 42: No. 11, 1584-9(Nov 1971).

A calorimetric technique was developed for measuring the ac loss in short, cylindrical thin film superconductors carrying a transport current. Substrates used in the present study were 0.32 cm in diameter by 3.8 cm long. Loss in the range 10^{-8} to 10^{-4} W may be determined by measuring the temperature rise at the center of the sample, which causes a decrease in resistance of a carbon resistance thermometer mounted inside the hollow cylindrical substrate on which the superconductor is deposited. By maintaining the current contacts at 4.2 K and heating the center of the sample (in a vacuum can), loss may be determined from 4.2 K up to the transition temperature of the superconductor. Data below 4.2°K are taken by lowering the temperature of the coolant bath. This technique has been used extensively to study the temperature dependent ac properties of Nb_3Sn. Typical loss data are shown. (auth)

5413 APPARATUS FOR MEASUREMENT OF TRANSITION TEMPERATURE OF SUPERCONDUCTING STATE OF THIN FILMS BY SIMULTANEOUS INDUCTIVE AND RESISTIVE METHODS. Golovashkin, A. I.; Onuchkin, V. M. Kratk. Soobshch. Fiz.; No. 4, 48-53(Apr 1971). (In Russian).

The inductive method was used to measure the self-inductive changes during transition of a coiled sample in the superconductive state. Measurement was performed on an alternating-current bridge, and the electrical resistance was simultaneously measured in an ordinary potentiometer circuit. Three types of samples were used in measurements in the superconducting state: a lead foil 170 Å thick, a foil of 70% Nb–30% Sn alloy, and a two-layered foil composed of a layer of Nb and a layer of Sn. The results showed that the inductive method serves for a quantitative estimate of the percentage composition of a laminated foil, multiphase alloy, etc. (K.S.W.)

5414 STRONG-COUPLING SUPERCONDUCTIVITY OF $Pb_{0.7}Bi_{0.3}$ ALLOYS. Adler, J. G.; Chen, T. T. (Univ. of Alberta, Edmonton). Solid State Commun.; 9: No. 22, 1961-4(15 Nov 1971).

Superconductivity of $Pb_{0.7}Bi_{0.3}$ was studied by electron tunneling techniques. This alloy was chosen because of its extremely strong electron–phonon interaction which leads to large deviations from the weak-coupling BCS theory. The temperature dependence of the energy gap along with the effective phonon spectrum, Coulomb pseudopotential, complex gap function, pairing self-energy and electron renormalization function were calculated from the data. (auth)

5415 THIRD-ORDER TERM IN FREE ENERGY OF GAPLESS DIRTY SUPERCONDUCTORS. de Lange, O. L.; Otter, F. A. Jr. Clarkson Coll. of Tech., Potsdam, N. Y.). Solid State Commun.; 9: No. 22, 1929-33(15 Nov 1971).

Usadel's calculation of the third-order coefficient $\phi_m(T) = -(1/6)\,(\partial^3 \Delta G_{mn}/\partial B^3)_{Bc2}$ in the Gibbs free energy of gapless dirty superconductors is related to the slope of the incremental entropy, S_{ij}, of vortices. Agreement with experiment is good in one alloy ($Nb_{85}Mo_{15}$) but not in $In_{60}Pb_{40}$. (auth)

5416 EXPERIMENTAL EVIDENCE FOR THE SPATIAL VARIATION OF THE GINZBURG–LANDAU PARAMETER IN SUPERCONDUCTORS. McEvoy, J. P.; Weber, J. (Clark Univ., Worcester, Mass.). Solid State Commun.; 9: No. 22, 1913-15 (15 Nov 1971).

A simple explanation is given for certain anomalies observed during magnetization studies of superconductors. In particular, it seems possible to understand the unusually large values of the surface nucleation field H_{c3} reported by several authors and the strange discontinuity in the magnetic moment of Type-II alloys near H_{c2} by considering the spatial variations of the Ginzburg–Landau parameter due to composition inhomogeneities affecting the mean free path. Experimental evidence is presented to support this notion for the two cases cited. (auth)

5417 SUPERCONDUCTING ENERGY GAP OF $NbSe_2$. Clayman, B. P.; Frindt, R. F. (Simon Fraser Univ., Burnaby, Can.). Solid State Commun.; 9: No. 22, 1881-4(15 Nov 1971).

The energy gap of $NbSe_2$, a superconducting layer structure, was measured to be 2.15 meV at 1°K by observing its far-infrared transmission spectrum. The temperature dependence of the gap is found to be consistent with BCS predictions. (auth) (UK)

5418 CRITICAL CURRENT DENSITY OF Pb–40 PERCENT Bi ALLOYS IN POROUS GLASS. Watson, J. H. P.; Hawk, R. M. (Corning Glass Works, N. Y.). Solid State Commun.; 9: No. 22, 1993-5(15 Nov 1971).

Measurements of the critical current density, J_c, for Pb–40% Bi in porous glass, with an average pore diameter of 35 Å, were made in transverse magnetic fields. Typically, $J_c \sim 10^5$ A/cm^2 in zero magnetic field and 10^4 A/cm^2 at 90 kG. (auth) (UK)

Equipment and Devices

Refer also to abstracts 5234, 5918, 5919, and 5925.

5419 SUPERCONDUCTIVE DIRECT-CURRENT CABLE. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,252,697. 10 Nov 1971. Priority date 21 Dec 1968, Germany.

A superconductive dc cable is described in which superconductors are supported by a flexible hollow conductor of normally conductive material. The superconductors may be arranged either in the walls of the hollow conductor or on its surface. In one form the hollow conductor consists of mutually supporting segments of any desired length, and the superconductors are arranged on the surface of the assembled hollow conductor and/or in the segments. The segments forming the hollow conductor expediently are of approximately Z-shaped cross section and are slightly curved. According to a further development, the segments have an approximately rectangular cross-sectional form and likewise are slightly curved. A hollow conductor assembled from the segments can also be, expediently, of multilayer formation.

According to a further development, the hollow conductor comprises a coil on which the superconductors are arranged. (M.H.R.)

5420 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTORS. (to Maschinenfabrik Oerlikon). British Patent 1,252,709. 10 Nov 1971. Priority date 8 Jul 1969, Switzerland.

The superconductor described is comprised of a hollow electrically normally conducting elongated support member and stabilized superconducting subconductors in the form of wires wound helically thereon that are bonded to the external surfaces of the support member by means of a thermally conducting nonmagnetizable fixing material. The fixing material consists of a tin alloy or of pure indium, the fusion temperature of which does not lie above 320°C. (M.H.R.)

5421 DESIGN CALCULATION OF ETL SUPERCONDUCTING SADDLE-SHAPED MAGNET. Koyama, Ken-ichi. Denki Shikensho Iho; 35: No. 5, 435-44(1971). (In Japanese).

The field distribution of a superconducting saddle-shaped magnet manufactured for a 1-kW MHD power generator is calculated, and the results are compared with the measured ones. Considering the accuracy of the measurement, the two are found to coincide very well. The electromagnetic forces exerted on the magnet structure are derived from the calculated field distribution, and the strength of the structural materials is discussed. (auth)

5422 CONSTRUCTION OF THE ETL SUPERCONDUCTING SADDLE-SHAPED MAGNET. Koyama, Ken-ichi; Todoriki, Itaru; Kawaskai, Yoshihara; (and others). Denki Shikensho Iho; 35: No. 5, 445-54(1971). (In Japanese).

A detailed explanation is given of the structure of a saddle-shaped magnet for a 1-kW MHD generator manufactured using a fully stabilized superconducting strip. The size of the magnet is 290 mm in bore diameter, 760 mm in outer diameter, and 910 mm in height. It is found out that the transition to the normal state takes place stably at 455 A, the central field being 24 kG and the maximum field 32 kG. The method of manufacturing the components of the magnet and that of composing them are given. Some remarks are given on building larger superconducting magnets. (auth)

5423 REFRIGERATING SYSTEM AND COOLING DOWN RESULTS OF SUPERCONDUCTING SADDLE-SHAPED MAGNETS FOR A 1-kW MHD POWER GENERATOR. Ushio, Kazuhiro; Shimamoto, Susumu; Nomura, Harehiko; (and others). Denki Shikensho Iho; 35: No. 5, 455-74(1971). (In Japanese).

A refrigerating system and a large dewar vessel were constructed to cool down saddle-shaped superconducting magnets for a 1-kW MHD power generator. The system is of an expansion-engine type, which sends out helium gas at the rate of 110 Nm^3/h, and the magnets are cooled down from room temperature to about 45°K. It takes 16 hours to cool down the magnet of 1,120 kg in weight from room temperature to 48°K, and 6.5 hours to feed the dewar with liquid helium up to 120 cm in depth, using 480 l of liquid helium. The efficiency of heat exchange between the magnet and the cooling gas is nearly 0.9. The evaporation rate of liquid helium in the dewar is 6 to 8 l/h, which corresponds to the decreasing rate of liquid helium level of 1.1 to 1.5 cm/h. (auth)

5424 EXPERIMENTS ON SUPERCONDUCTING SADDLE-SHAPED MAGNETS FOR A 1-kW MHD POWER GENERATOR. Onishi, Toshitada; Koyama, Ken-ichi; Kaiho, Katsuyuki; (and others). Denki Shikensho Iho; 35: No. 5, 475-97(1971). (In Japanese).

Some of the principal results are given of experiments on the magnets, each with 5 or 11 layers of wire, SG-500,of AVCO Co., Ltd. The 11-layer magnet, 29 cm in bore diameter, about 76 cm in outer diameter, and 91.3 cm in lenth, carries approximately 455 A in its critical current, and 24 kG in the corresponding maximum magnetic field at the center of the magnet. The magnetic field energy stored in the 11-layer magnet is removed with a 0.79-Ω parallel resistance to the extent of 80 to 100%. The 11-layer magnet is fully stabilized and, therefore, a superconducting state is recovered when the current is gradually decreased after transition to the normal state occurs; such is not the case in the 5-layer magnet, whose normal region grows catastrophically. Inductance of the magnets, voltage characteristics appearing across the terminals of the coils, temperature of the coils, resistance of the joints between the windings and the current leads, inner pressure of the dewar, etc., were measured. In addition, calculated and measured values of a resistance that appear in the coils are compared. (auth) (Japan)

5425 EXPERIMENTS ON MECHANICAL PERSISTENT SWITCHES FOR SUPERCONDUCTING MAGNETS. Kawasaki, Yoshiharu; Koyama, Ken-ichi; Todoriki, Itaru. Denki Shikensho Iho; 35: No. 5, 498-512(1971). (In Japanese).

Considering that a mechanical persistent current switch is the most feasible type for superconducting magnets wound with composite conductors with a large amount of normal metal substrate, several kinds of mechanical contacts were tested both in liquid nitrogen and in liquid helium for the purpose of developing a switch of this type for a saddle-shaped superconducting magnet for a 1-kW MHD generator. As a result, a switch with less than 0.1μΩ in contact resistance in liquid helium and more than several hundred amperes in current capacity was developed and tested successfully with the 24-kG saddle-shaped superconducting magnet. Some design considerations are also given for constructing switches of higher current capacity for future superconducting magnets of larger scales. (auth)

5426 SOME PROBLEMS IN CALCULATIONS ON SUPERCONDUCTING COAXIAL TRANSMISSION LINES. Migunov, L. V. Izv. Vyssh. Ucheb. Zaved., Radioelektron.; 14: No. 5, 581-2(May 1971). (In Russian).

Analysis of losses in superconducting coaxial lines shows that the dielectric losses in the fluorine layer (= 4) become commensurate with losses in superconducting guide lines at frequencies of 7 to 9 GHz. The effect of dielectric loss on the parameters of the lines was examined. The subsequent theoretical development is applied to an example of a Nb–Pb superconducting coaxial line 0.125 mm in diameter, filled with fluorine-containing material. The attenuation of 2,000 m of this line was calculated, and it is concluded that dielectric losses may be disregarded only in a line 500 m or less in length. (K.S.W.)

5427 STABILIZATION OF SUPERCONDUCTING WIRES BY MAGNETIC DAMPING OF HIGH ELECTRIC-CONDUCTIVITY METAL. Onishi, Toshitada; Todoriki, Itaru. Denki Shikensho Iho; 35: No. 2, 115-28(1971). (In Japanese).

The magnetic damping effect of a high-electric-conductive metal coating on the stability of superconductors was studied. It was found that the effect markedly damps such changing magnetic fields. The stability of superconducting wires was investigated qualitatively from the point of view of the electric conductivity and thickness of the coated metal. It was concluded from the results that, if the metal less than 25- to 50-μm thick is used for the stabilization of superconducting wires, it is considered necessary to use metal a few times better in conductivity at 60 kG than copper (OFHC) conventionally used. It is predicted to be possible to determine the stability or the instability region of superconducting wires on the coordinates of the conductivity and thickness of the coated metal. (auth)

5428 ELECTRICAL CHARACTERISTICS OF SUPERCONDUCTING CABLE. Ito, Noboru. Denki Shikensho Iho; 35: No. 2, 161-71(1971). (In Japanese).

Design considerations and electrical characteristics of superconducting cables for extra large blocks of dc and ac power transmission are described. In the cable design the supercritical helium (10 atm., 5 ~ 7°K) and the fluid nitrogen (5 atm., 77 ~ 87°K) are used for cooling, Nb–Ti (Nb–Zr) for dc or Nb for ac, as a conductor with a safety factor which is equal to the ratio of ordinary fault current and normal operating current; and Al backing, for conductor protection. Electrical characteristics of superconducting cable by the design method described in the paper are given, and then their effects on power systems to which the superconducting cable is to be introduced are described. The charging capacity of superconducting ac cable and an optimum operating voltage of the cable are discussed. It is also made clear by an economic study of both kinds of superconducting cables that the superconducting dc cable transmission has a more economical region (e.g., 5 GW over 100 km, 10 GW over 150 km) than the ac cable. (auth) (Japan)

5429 ^{3}He-^{4}He DILUTION REFRIGERATOR. Pederson, Donald Otis. Houston, Tex.; Rice Univ. (1971). 128p. University Microfilms Order No. 71-26,338.

Thesis.

A general description of the dilution refrigerator and its operation are given. The principal differences from other refrigerators are the design of the still which includes a ^{4}He film-flow-limiting evaporator and the use of high-purity silver in the heat exchangers. The refrigerator achieved temperatures less than 55 mK for several hours. These temperatures were obtained on the outside of the mixer where any practical application of the cooling power will occur. Instabilities in the operation of the refrigerator have restricted the analysis of the refrigerator and its use. There are indications that the ^{4}He film-flow limiter has some effectiveness. Suggestions are made that might solve the instabilities so that the refrigerator can be studied and operated routinely. (Diss. Abstr. Int., B)

5430 PARAMETRIC CONVERSION AND AMPLIFICATION WITH THE USE OF SUPERCONDUCTING POINT CONTACTS. Vystavskii, A. N.; Gubankov, V. N.; Leshchenko, G. F.; Likharev, K. K.; Migulin, V. V. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 15: No. 11, 2121-4(Nov 1970).

Some possible parameters of amplifying and conversion systems are evaluated, using superconducting point contacts as the parameter element and the normal Josephson oscillation as the pumping oscillation. (M.H.R.)

5431 PARAMETERS AND METHODICS FOR CALCULATING SUPERCONDUCTING MAGNETIZING OPTIMAL FORM SYSTEM. Grinberg, G. K.; Laumanis, I. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 75-8(1971). (In Russian).

A magnetizing system consisting of two parallel superconductors with opposing currents is considered. The system can be applied to magnetic field excitation in MHD machines. Magnetic and geometric parameters characterizing the system and the methodics for its calculation are determined. (auth)

5432 HORIZONTAL DILUTION REFRIGERATOR WITH VERY HIGH COOLING POWER. Niinikoski, T. O. (Helsinki Univ. of Tech., Otaniemi, Finland. CERN, Geneva). Nucl. Instrum. Methods; 97: No. 1, 95-101(1971).

A horizontal, high-cooling-power, dilution refrigerator was built and tested for studying the feasibility of a spin-frozen, polarized proton target to be used at CERN in the Omega spectrometer. In test conditions the following performance was observed: cooling power 6.3 mW at 0.5 K, 2.3 mW at 0.3 K, and 0.19 mW at 0.1 K; cooling time 5 min from 0.5 K to 0.1 K and 20 min from 0.1 K to 0.030 K. The lowest temperature in continuous operation was 22 mK. The refrigerator has a tubular counterflow heat exchanger and two discrete, sintered copper heat exchangers of a new type. (auth)

5433 COMMENTS ON DESIGN FEATURES OF AC SUPERCONDUCTING CABLES. Guthrie, G. L. (WADCO Corp., Richland, Wash.). J. Appl. Phys.; 42: No. 13, 5870-1(Dec 1971).

Long and Notara (J. Appl. Phys., 42: 155(1971)) analyzed the emergency overload capability and other design features of niobium superconducting ac cables. The principal equation used in the analysis contains a term, which is an empirical fit, whose functional form allows a reasonable relation to theory over only a limited range of the variables. The use of this term for cable design leads to a cable whose power-carrying capability is greatly decreased compared to a cable designed from a theoretically sound analysis using the same materials and the same outer diameter of the cable. The decrease in power-carrying capability is due to a poor choice for the ratio of inner to outer diameter of the coaxial cable in the calculation. Corrections that give a more favorable ratio are indicated. (M.H.R.)

5434 ULTRA-HIGH-SPEED OPERATION OF JOSEPHSON TUNNELING DEVICES. Zappe, H. H.; Grebe, K. R. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). IBM J. Res. Develop.; 15: No. 5, 405-7(Sep 1971).

Switching times of large Josephson devices were measured. Gate switching times of 85 ps and array cycle times of an elementary memory cell of 550 ps are reported. Although these times are expected to be smaller in more realistic miniaturized devices, they represent the shortest times for such circuits ever reported in any technology. (auth)

5435 THIN DIELECTRIC FILMS IN SUPERCONDUCTING CAVITIES. Garwin, E. L.; Rabinowitz, M. (Stanford Univ., Calif.). Lett. Nuovo Cim.; 2: No. 9, 450-2(28 Aug 1971).

It is proposed that rather than merely adding to the metal a dielectric layer that reduces the local electric field by a factor (the dielectric constant), anodization of niobium converts small conducting protrusions into dielectric material, thus vastly reducing or entirely eliminating their ability to enhance both electric and magnetic fields. An upper-limit calculation of the loss tangent of Nb_2O_5 is made. (M.H.K.)

5436 SUPERCONDUCTING CYLINDRICAL WAVEGUIDES AT MICROWAVE FREQUENCIES. Zepp, G. (Univ., Clermont-Ferrand, France). Rev. Phys. Appl.; 6: No. 2, 135-41(Jun 1971). (In French).

The behavior of a cylindrical superconducting waveguide (with a large coherence length) was studied. Variations in the attenuation coefficient, phase shift, and field penetration depth were investigated as a function of the degree of impurity present. (auth)

Plasma and Thermonuclear Physics

5437 ADVANCES IN PLASMA PHYSICS. VOLUME 4. Simon, Albert; Thompson, William B. (eds.). An Interscience Series. New York; John Wiley and Sons, Inc. (1971). 355p.

Separate abstracts were prepared for the 7 included sections. (M.O.W.)

For abstracts of individual sections see: 5148, 5320, 5444, 5475, 5526, 5553, and 5683.

5438 PLASMA PHYSICS INDEX. VOLUME 6, No. 10, 1971. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 166p.

This listing contains 522 references on various aspects of plasma physics. (M.O.W.)

5439 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 10, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 50p. (In German and English).

This listing contains 280 references on various aspects of plasma physics and fusion reactor research. (M.O.W.)

Confinement and Heating

5440 (AEC-tr-7282) TURBULENT HEATING OF IONS IN SKINNED HIGH-FREQUENCY DISCHARGE. Dubovoi, L. V.; Ivanov, V. A.; Chernobrovin, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Leningrad). Translation of report NP-18187. 18p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 23944. (M.O.W.)

5441 (AEC-tr-7284) TRANSPORT PROCESSES IN TOROIDAL MAGNETIC TRAPS. I. INITIAL EQUATIONS. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-18340. 32p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 42644. (M.O.W.)

5442 (CTO-770) TURBULENCE AND HEATING IN A PLASMA CARRYING A TRANSVERSE CURRENT. Demchenko, V. V.; Sizonenko, V. L.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by J. B. Sykes (Culham Lab., Abingdon, Eng.), from report KHFTI-70-62. 14p. Dep. NTIS (U. S. Sales Only).

Estimates are given for the magnitude of the turbulent fluctuations of density and velocity of electrons and ions and of the electric field in a plasma carrying a current at right angles to the magnetic field, in which hydrodynamic beam instability develops with frequency and growth rate Re $\omega \approx$ Im $\omega \approx \min[\sqrt{(\omega_{He}\omega_{Hi})}, \omega_{pi}]$. Here $\omega_{He,i}$ are the electron and ion gyrofrequencies, ω_{pi} the ion plasma frequency; it is assumed that $v_{Ti} \ll U_\perp \ll v_{Te}$, where $U_\perp$ is the relative velocity of the electrons and ions, $v_{Te,i}$ their thermal velocities. An estimate is made of the cross section for Raman scattering of microwaves by turbulent fluctuations of the electron density, and the values obtained are compared with the experimental results. It is shown that in such a plasma there exists an effective mechanism for heating of nonresonant ions, due to the finite correlation time of the electric field fluctuations. The increases of the transverse ion temperature T_i and the longitudinal electron temperature T_e depend on the relationship $dT_i/dt \approx (\omega_{Hi}^2/|\omega|)m_i U_\perp^2$. The heating continues so long as $U_\perp > v_{Ti}$ and the ion Larmor radius $\rho_i = v_{Ti}/\omega_{Hi}$ is less than the radius of the containing vessel. (auth)

5443 COLLISIONAL DIFFUSION IN THE dc OCTOPOLE. Ohkawa, Tihiro; Gilleland, John R.; Tamano, Teruo; Takeda, Tatsuoki; Bhadra, Dilip K. (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. Phys. Rev. Lett.; 27: No. 18, 1179-81(1 Nov 1971).

The collisional diffusion coefficient is measured in the dc octopole plasma. All measurements indicate that the process is classical diffusion for the bulk of the plasma. The value of the coefficient agrees with the theoretical value within the experimental error. Also anomalous transport is observed in the average minimum-B region which becomes large near the minimum-length flux line. (auth)

5444 CUSP CONTAINMENT. Spalding, Ian (Univ. of Maryland, College Park). Advan. Plasma Phys.; 4: 79-123 (1971).

Earlier theoretical work on equilibrium, gross stability, and quiescent confinement in cusp geometries is summarized. An assessment of the reactor feasibility of open-ended high-β systems is outlined. A summary is given of the main results of published cusp experiments and some points of contact with other active branches of plasma and geophysics. 109 references. (M.O.W.)

5445 MAGNETOHYDRODYNAMIC EQUILIBRIUM OF A FINITE-β CYLINDRICAL PLASMA WITH BUMPY FIELD. Mat-

suura, Kenya (Electrotechnical Lab., Tokyo). Denki Shikensho Iho; 35: No. 7, 603-21(1971).

A magnetohydrodynamic equilibrium of cylindrical diffuse pinch with a bumpy field configuration is investigated by using the well-known equilibrium equation for a flux function. The dependence of the pressure on the flux function is assumed to be in the form of an exponential function. Then, without using a model in which the considered system is divided into the region of plasma column and the vacuum region surrounding the column, the configuration can be obtained in which the main part of the plasma is separated from the wall by the vacuum-like field. Such a situation of the configuration becomes more excellent as the value of β increases. This investigation is considered to be useful as the first step of the study of the equilibrium of a high-β toroidal bumpy plasma that has the complicated structure of the magnetic surface. (auth)

5446 CONVECTIVE MOTIONS DUE TO TRAPPED PARTICLES OF PLASMAS CONFINED IN AN l = 3 STELLARATOR FIELD. Miyamoto, Kenro; Mohri, Akihiro; Inoue, Nobuyuki; Fujiwara, Masami; Yatsu, Kiyoshi (Nagoya Univ., Japan). Phys. Fluids; 14: No. 12, 2748-50(Dec 1971).

Confinement of the plasmas in a stellarator of l = 3 is studied. The distribution of density and potential over the plasma cross section shows the existence of convective cells due to the trapped particles at the three corners of the magnetic surfaces, where the magnitude of the field is a minimum along the lines of force. The observed decay time can be explained in an order-of-magnitude discussion by the observed convective motions and the low-frequency fluctuations observed in the boundary region. (auth)

5447 COMPUTER CALCULATIONS OF ELECTRON CYCLOTRON HEATING IN A NONUNIFORM MAGNETIC FIELD. Sprott, J. C.; Edmonds, P. H. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 14: No. 12, 2703-7(Dec 1971).

A computer is used to calculate the trajectories of a collection of noninteracting, nonrelativistic electrons near the axis of a spatially sinusoidal, dc magnetic field in the presence of a spatially homogeneous, perpendicular rf electric field. The computed heating rate is in good agreement with the prediction of various equivalent stochastic models for a wide variation of parameters. The distribution is approximately Maxwellian, and the particles tend to turn at the resonance surface. Departure from the stochastic theory is observed for high-energy particles that turn near the resonance surface, and a condition for stochasticity is derived. Trapping of particles initially in the loss cone is observed with strong electric fields. (auth)

5448 NEW METHOD OF MAGNETIC ENERGY PUMPING INTO A PLASMA. Akhiezer, A. I.; Aleksin, V. F.; Khodusov, V. D. (Physical-Technical Inst., Kharkvw). Nucl. Fusion; 11: No. 5, 403-9(Oct 1971).

In the case of high-intensity plasmons, interaction processes among the plasmons are more probable than interaction processes of plasmons with plasma particles; plasma relaxation occurs in two stages: first, statistical equilibrium in the plasmon subsystem is established, characterized by a temperature different from that of particles, and then in a slower process equality of plasmon and particle temperatures is established. The plasmon energy may be increased by slowly modulating the external magnetic field on which the plasmon frequencies depend. The energy pumped into the plasmon subsystem by this method—which may be called the method of magnetic pumping—may be much higher than the Joule heat immediately obtained by the particles. The energy obtained by plasmons will be transferred slowly to the particles; in the plasmon subsystem itself a stationary energy level will be established. Thus, in a nonisothermal plasma, mainly the electrons will be heated. (auth)

5449 MEASUREMENT OF THE DIFFUSION LIFETIME OF A PLASMA IN TOKAMAK-3 BY THE NEUTRAL HYDROGEN INJECTION METHOD. Gorbunov, E. P.; Mirnov, S. V.; Parfenov, D. S. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 11: No. 5, 433-40(Oct 1971).

A description is given of experiments with the pulsed injection of a neutral gas during discharge in Tokamak-3. The electron concentration was measured by a method of multichord probing with 2-mm waves. The flow of neutral gas from the chamber walls and from the diaphragm was determined from measurements of the intensity of the hydrogen spectral line in three directions. The diffusion lifetime in the experiments described is in the range 20 to 30 ms, and the halt in the reduction of the electron concentration observed in the intermediate discharge stage is not associated with an increase in the flow of neutral gas but with an improvement in the plasma confinement. The flows from the diaphragm and from the chamber walls are compared, as are the diffusion and energy lifetimes. (auth)

5450 OFF-RESONANCE EFFECTS ON ELECTRONS IN MIRROR-CONTAINED PLASMAS. Dandl, R. A.; Eason, H. O.; Edmonds, P. H.; England, A. C. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 11: No. 5, 411-23(Oct 1971).

Resonant heating by microwave power was used to produce high-β plasmas with electron temperatures near 1 MeV. Typically, plasmas are produced with $\omega_{pe} \sim \omega_{ce}$. Further experimental heating studies described here show that a large increase in stored plasma energy is produced by microwave power with a frequency higher than the cold-electron resonance frequency. This increase, caused by off-resonance heating, is attributed both to stochastic heating and to the control of an instability through changes in the electron distribution function. Alternatively, a decrease in the stored plasma energy is produced by microwave power at a frequency below the cold-electron resonance frequency. This effect is attributed in part to enhanced diffusion into the loss cone. However, a small fraction of the plasma is heated to high energies. (auth)

5451 PLASMA HEATING BY ENERGETIC PARTICLES. Sigmar, D. J.; Joyce, G. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 11: No. 5, 447-56(Oct 1971).

The interaction of a tenuous energetic test-particle species with a multispecies high-temperature plasma is calculated. The Balescu–Lenard kinetic equation is used in order to include collective effects through the dielectric constant. Quantum corrections are made for close collisions. The theory is first applied to the slowing down of fusion-born alpha particles in a mirror-confined plasma, and theory and numerical results are compared to previous treatments and corrections are found. In Tokamak-like plasmas most of the alpha-particle energy goes into the electrons, and the thermalization time is somewhat larger than the plasma lifetime but heating can nevertheless be substantial. Heating of a Tokamak-like plasma by injection of energtic neutrals is shown to be effective at injection energies ≤70 keV, possibly doubling the ion temperature when the injected particle density reaches 1% of the plasma density. For analytic estimates, a simple binary collision model for injection heating is given. (auth)

5452 LOWER HYBRID HEATING IN AN INHOMOGENEOUS CYLINDRICAL PLASMA. Pesic, S. S. (CEN, Grenoble, France). Nucl. Fusion; 11: No. 5, 461-9(Oct 1971).

The interaction of extraordinary waves with an inhomogeneous anisotropic plasma column at the lower hybrid frequency is investigated within the framework of the cold plasma theory. Numerical results for the wave absorption efficiency are presented for a wide range of plasma densities, magnetic field strengths, effective collision frequencies, and column dimension values. Strong wave absorption occurs when the magnetic field strength approaches the value that corresponds to the ion cyclotron frequency. The plasma column exhibits a series of geometric resonances in the medium-frequency range and a main absorption resonance in the hf range. The influence of temperature and nonlinear effects on the obtained absorption efficiency in the lower-hybrid-frequency range is discussed. (auth)

5453 PLASMA HEATING BY HIGH-CURRENT RELATIVISTIC ELECTRON BEAMS. Lovelace, R. V.; Sudan, R. N. (Naval Research Lab., Washington, D. C. Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 27: No. 19, 1256-9(8 Nov 1971).

The mechanism proposed for heating plasma with a high-current relativistic electron beam makes essential use of the plasma return current induced by the beam. From overall energy conservation it is concluded that a large fraction of the beam energy is converted into plasma thermal energy. For reasonable parameters the heating occurs through ion sound turbulence generated by the plasma return current. (auth)

5454 CONFINEMENT OF OHMIC-HEATED PLASMA IN THE URAGAN STELLARATOR WITH HIGH SHEAR. Vishnevetskii, V. N.; Volkov, E. D.; Dikii, A. G.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 751-6(May 1971). (In Russian).

Investigations of ohmic-heated plasma confinement in a stellarator with high shear are discussed. It is shown that the confinement time relative to the Bohm value increases with the shear growth and rotational transform. For a shear of about 0.085 the relative confinement time is about 30 τ_B (τ_B is the Bohm time). The experimental data are in satisfactory agreement with the theory. (auth)

5455 CALCULATION OF THE EQUILIBRIUM OF AXISYMMETRIC TOROIDAL PLASMAS FROM THE SHAFRANOV EQUILIBRIUM CONDITION. Belitz, H. J. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 247: No. 3, 275-88(1971). (In German).

A two-dimensional power series was used for the following:

(a) to approximate the solution of the elliptic boundary-value problem, which corresponds to the Shafranov equilibrium condition for a plasma confined in axisymmetric toroidal geometry, and (b) to calculate the physical quantities as plasma pressure, currents, and magnetic field intensities. The coefficients of the series depend on certain arbitrary parameters. Additional conditions (e.g., plasma pressure $p \geq 0$, $I^2 \geq 0$) lead to some restrictions for these parameters. (auth)

5456 INFLUENCE ON CORRUGATION OF THE MAGNETIC FIELD ON THE EXPANSION AND COOLING OF A DENSE PLASMA. Budker, G. I.; Mirnov, V. V.; Ryutov, D. D. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Engl. Transl.); 14: No. 5, 212-15(5 Sep 1971).

[25]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 320-2(5 Sep 1971).

A method is proposed for decreasing the thermal conductivity and velocity of escape of the plasma along the field. A corrugated magnetic field is used with a corrugation period l much shorter than the mean free path λ. The system is transformed into a set of probkotron mirror machines with interconnected ends. It is shown that this configuration leads to the desired effects. (M.O.W.)

Diagnostics

Refer also to abstract 5328.

5457 (AEC-tr-7280) RECORDING OF PLASMA OSCILLATIONS INDUCED BY EXTERNAL SUPERHIGH-FREQUENCY FIELD. Batanov, G. M.; Sarksyan, K. A.; Silin, V. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-18471. 9p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 51617. (M.O.W.)

5458 MODERN OPTICAL METHODS IN GAS DYNAMIC RESEARCH. Proceedings of an International Symposium Held at Syracuse, New York, May 25-26, 1970. Dosanjh, Darshan S. (ed.). New York; Plenum Publishing Corporation (1971). 306p. $14.50. (CONF-700565).

Separate abstracts were prepared for 4 of the included papers. The remaining papers were not in the scope of NSA and were omitted. (M.O.W.)

For abstracts of individual papers see: 5459-5461 and 5515.

5459 TEMPERATURE ERRORS IN PLASMA DIAGNOSTICS AND THEIR POSSIBLE EFFECTS ON ABSOLUTE TRANSITION PROBABILITIES. Wares, Gordon W.; Wolnik, Stanley J.; Berthel, Robert O. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 49-60 of Modern Optical Methods in Gas Dynamic Research. /Dosanjh, Darshan S. (ed.). New York; Plenum Publishing Corp. (1971).

From Symposium on modern optical methods in gas dynamic research; Syracuse, N. Y. (25 May 1970).

Plasma temperature data taken in shock tubes, wall-stabilized arcs, atomic beam, and radiative lifetime techniques are compared. A brief discussion of each method is given. (M.O.W.)

5460 SOME OPTICAL DIAGNOSTIC TECHNIQUES INVOLVING HIGH-POWER LASERS. Alcock, A. J. (National Research Council of Canada, Ottawa). pp 119-35 of Modern Optical Methods in Gas Dynamic Research. /Dosanjh, Darshan S. (ed.). New York; Plenum Publishing Corp. (1971).

From Symposium on modern optical methods in gas dynamic research; Syracuse, N. Y. (25 May 1970).

Some examples of optical interferometry and Schlieren photography involving high power lasers are described. The examples are for nanosecond and subnanosecond resolutions. (M.O.W.)

5461 ANALYSIS OF PLASMA BY LIGHT SCATTERING. Lovberg, Ralph H. (Univ. of California, San Diego). pp 155-76 of Modern Optical Methods in Gas Dynamic Research. /Dosanjh, Darshan S. (ed.). New York; Plenum Publishing Corp. (1971).

From Symposium on modern optical methods in gas dynamic research; Syracuse, N. Y. (25 May 1970).

A review is given on the use of lasers for plasma diagnostics. A theory for light scattering on plasmas with fluctuations is given. In addition, experimental apparatus and techniques are described. (M.O.W.)

5462 DIRECT DISPLAY OF PLASMA DENSITY AND TEMPERATURE. Kawashima, Nobuki; Yamori, Akira (Tokyo Univ.). J. Appl. Phys.; 42: No. 13, 5400-1(Dec 1971).

A direct-display plasma density and temperature meter was developed using a floating double-probe method. A small ac voltage was superposed on the dc voltage, and the third harmonic component of ac current was detected. The phase reversal of the third harmonic component was observed at $V_{dc} = V^* = 1.30\ kT_e$, and an experiment was carried out to fix the dc voltage automatically at this voltage V^* detecting the phase reversal of the third harmonic component. The plasma density and electron temperature were obtained directly from the dc voltage V^* and the dc current corresponding to the voltage V^*. (auth)

5463 STUDY OF THE ELECTRON TEMPERATURE AND ELECTRON DENSITY OF AN INDUCTIVE hf DISCHARGE IN HYDROGEN USING A SYMMETRIC DOUBLE PROBE. Turban, Guy (Univ., Nantes, France). Compt. Rend., Ser. B; 273: No. 13, 533-6(27 Sep 1971). (In French).

The measurements were made during the second stage of the discharge at pressures varying between 0.1 and 0.01 torr. The shielding of the axial hf field has a strong effect on the radial profiles of T_e and N_e. (France)

5464 DIFFRACTION OF MILLIMETER WAVES BY A SPHERICAL PLASMA. MEASUREMENTS OF HIGH ELECTRON DENSITIES. Archambault, Y. (Thomson-CSF, Orsay, France). Rev. Phys. Appl.; 6: No. 2, 199-200(Jun 1971). (In French).

A method of calculating the diffraction of electric millimeter waves by a spherical plasma is given. The electron density, and the electron density gradient of the plasma are unrestricted. The method is applied to the interpretation of interferometric measurements on a plasma of known profile. The calculation demonstrates that the interpretation valid at low electronic densities ($N \ll N_c$, N_c = cutoff density) may be extended to higher densities. Electron densities were experimentally determined for an afterglow cesium plasma $N <= 3 \times 10^{13}\ cm^{-3}$, good agreement with independent optical methods was obtained. (France)

5465 DIAGNOSTICS USING 8 mm INTERFEROMETRY OF A QUASI-RECTANGULAR SECTION PLASMA PRODUCED BY A REFLEX DISCHARGE. COMPARISON OF THE RESULTS OBTAINED FOR Ar AND Ne. Bottreau, A.; Marzat, C. (Univ., Bordeaux). Rev. Phys. Appl.; 6: No. 2, 241-5(Jun 1971). (In French).

Measurements of the phase and complex transmission modulus of a plasma enabled the full width at half-maximum of the electron distribution curve and the density at the center, to be deduced in terms of the discharge parameters. For a given device geometry a typical curve may be obtained that enables the electron distribution characteristics of the plasma to be obtained from a single measurement (phase transmission coefficient modulus). (France)

5466 DETERMINATION OF ELECTRON DENSITY PROFILES FROM TONKS-DATTNER RESONANCE DATA IN PLASMAS. Baird III, A. W. (Sperry Rand Research Center, Sudbury, Mass.). J. Appl. Phys.; 42: No. 13, 5358-61(Dec 1971).

A technique is described for deducing an unknown electron density profile from observed Tonks-Dattner resonance frequencies, which uses a simple resonance condition derived from the WKB approximation. The density profile is approximated by a step model, piecewise-linear model, step-piecewise-linear model, and polynomial model in both active and afterglow plasmas in plane-parallel and cylindrical geometries. Good agreement is obtained between the profile determined by this technique and one obtained theoretically. (auth)

5467 SHEATH-CONVECTION EFFECTS WITH FLUSHED-MOUNTED ELECTROSTATIC PROBES. Clements, R. M. (Univ. of Victoria, British Columbia); Smy, P. R. Can. J. Phys.; 49: No. 20, 2540-6(15 Oct 1971).

Theoretical expressions are derived for the ion current to a planar flush-mounted probe that arises from the convection of ions from a moving plasma into the probe sheath. The two situations considered are those where the sheath is either very large or is small compared with the boundary layer. It is found that sheath effects, with an accompanying lack of true current saturation with increasing probe bias, can be expected to intrude when the parameter $R_E\alpha^2\chi^2 > (X/l)^{\frac{1}{2}}$. ($R_E$ = electric Reynold's number, α = ratio of Debye length to probe length [X], χ = potential of probe normalized with respect to the electron energy, and l = the distance of the probe from the leading edge of the surface into which it is mounted.) For values of $R_E\alpha^2\chi^2(l/X)^2$ which exceed unity, the formula $j = 1.46\ n_e^{\frac{1}{2}}u_\infty^{\frac{1}{2}}V^{\frac{1}{4}}X^{-\frac{1}{4}}\mu_\infty^{\frac{1}{2}}\epsilon_0^{\frac{1}{4}}e^{\frac{1}{4}}$ (m.k.s.) (where n_e = plasma electron density, u_∞ = free stream flow velocity, V = probe bias, μ_∞ = free stream ion mobility, e = electronic charge, and ϵ_0 = permittivity of free space) is derived. At lower values of $R_E\alpha^2\chi^2(l/X)^2$ theoretical considerations which take compression and cooling effects into account show that the above relation should still be approximately correct down to values of $R_E\alpha^2\chi^2 \simeq 1$. The relation shows good agreement with the recent results presented by Scharfman and Bredfeldt under conditions where they report the conven-

tional diffusion theory to be in error by up to one order of magnitude, and moreover to predict an incorrect variation of current with electron density and probe bias. (auth) (Canada)

5468 SIMPLE METHODS FOR DETERMINING m/z OF PARTICLES IN QUASISTATIONARY PLASMAS. Kuswa, Glenn W. (Univ. of Wisconsin, Madison). Rev. Sci. Instrum.; 42: No. 11, 1734-6(Nov 1971).

A new technique is described for plasma mass spectroscopy, using the low-energy cutoff properties of ions entering a system biased relative to the plasma. Two alternative methods are briefly discussed. (M.O.W.)

5469 GEOMETRY FACTORS OF CAVITY RESONATORS FOR DETERMINATION OF PLASMA ELECTRON DENSITY, DENSITY PROFILE, AND COLLISION FREQUENCY. Janzen, G. (Univ., Stuttgart). Z. Naturforsch.; 26a: No. 8, 1264-71(Aug 1971). (In German).

Geometry factors of a number of cylindrical TF_{1mn} and TM_{1mn} cavity resonance modes are calculated as a function of the ratio of plasma and cavity radius and as a function of the radial electron density profile. In the axial direction, homogeneous and sinusoidal density profiles are assumed. Resonance modes with a small index l are suitable for the measurement of electron densities in narrow and dilute plasma columns; modes with an index $l \geq 2$ are specially advantageous for measuring the density profile. Results of measurements of the electron density, density profile, and collision frequency in nitrogen are given. (auth)

5470 MULTIBEAM SCHLIEREN OSCILLOSCOPE FOR PULSED PLASMA. Beshaposhnikov, A. A.; Zukakishvili, G. G.; Kuchuberiya, I. Kh.; Semonova, N. V. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 503-5(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 151-3(Mar-Apr 1971).

The circuit of a multibeam schlieren oscilloscope, which allows the distribution of the electron density gradients along the diameter of a discharge chamber to be recorded, is described. The circuit is simple and reliable to operate; its operation is illustrated by the seven-beam schlieren oscillograms of the first half-cycle of a combined pinch discharge. The method is convenient for studying the dynamics of processes in plasmas. The sensitivity of the circuit is $\sim 6 \times 10^{15}$ cm^{-3}, and its time resolution is 0.1 μsec. (auth)

Kinetics (General)

Refer also to abstract 5280.

5471 (AEC-tr-7279) DIFFUSION IN EXPERIMENTS ON HIGH-FREQUENCY STABILIZED PLASMA. Dubovoi, L. V.; Shanskii, V. F. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translation of report NP-18145. 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 17896. (M.O.W.)

5472 (MATT-850) ANALYTIC ORDERINGS GENERATED BY COMPUTER. Rosen, Bernard; Winsor, Niels K. (Princeton Univ., N. J. Plasma Physics Lab.). Nov 1971. Contract AT(30-1)-1238. 11p. Dep. NTIS.

This report describes a computer program ORDERS, which performs analytic expansions. It accepts as input a set of equations, variables, and functions. One can then specify an ordering of the variables and functions in terms of an expansion parameter ϵ, and expand the equations to any desired order in ϵ. The operation of ORDERS and a practical example of its use in magnetohydrodynamics are discussed. (auth)

5473 (SC-RR-710560) PHOTOIONIZATION OF N_2 AND O_2 AHEAD OF STRONG SHOCK WAVES IN A SHOCK TUBE. Mulac, A. J. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 45p. Dep. NTIS.

An improved calculation of photoionization ahead of strong shock waves in N_2 and O_2 was carried out. In contrast to previous calculations, these calculations include a more detailed kinetic model, a source of finite extent, and wall reflection. Very good agreement (±20%) was obtained between calculated values of electron density and values measured in the experiments of Presley and Omura. (auth)

5474 CONICAL Z-PINCH GUN. Mendel, C. W. Jr. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 42: No. 13, 5483-91(Dec 1971).

A pulsed plasma gun is described that has several advantages over other commonly used guns. Among these are simplicity of operation, construction and analysis, and stability of operation. The output has a sharply peaked velocity distribution. The initial model, described herein, emits a burst of 5×10^{18} Ar ions moving at 9 cm/μsec. A snowplow analysis predicts operating characteristics generally in agreement with observations. (auth)

5475 PHYSICS OF COLLOIDAL PLASMAS. Sodha, M. S.; Guha, S. (Indian Inst. of Tech., New Delhi). Advan. Plasma Phys.; 4: 219-309(1971).

The equilibrium and nonequilibrium statistical mechanics of the ionization of solid particles are reviewed. Ionization and recombination of electrons with negatively charged solid particles, dependence of Fermi energy on the size of the particle, and field emission from these particles are discussed. Possible applications of the colloidal plasmas are discussed. 161 references. (M.O.W.)

5476 THERMODYNAMIC DIAGRAMS FOR HIGH-TEMPERATURE PLASMAS OF AIR, AIR–CARBON, CARBON–HYDROGEN MIXTURES, AND ARGON. Kroepelin, H.; Neumann, K.-K.; Hoffmann, K.-U.; Kuthe, R. Elmsford, N. Y.; Pergamon Press, Inc. (1971). 194p. $20.00. (In German and English).

Information is given relating to the properties of equilibrium gas plasmas formed from hydrocarbons, from air without argon, from pure argon, and from mixtures of air and carbon at various compositions, temperatures, and pressures. The data are presented in graphical form. (M.O.W.)

5477 THERMAL LOAD CAPACITY OF A TOROIDAL WALL AT PLASMA INCLUSION. Krichel, R.; Druxes, H.; Schmitz, G. (Technische Hochschule, Aachen). Z. Phys.; 248: No. 1, 13-21 (1971). (In German).

A model theory is demonstrated by which it is possible to determine the load capacity of a wall including an electric arc. This theory is based on exact numerical computations of the temperature distribution inside the wall of a toroidal arc tube. It is shown and explained that the thermal load capacity increases with the radius of curvature at fixed tube radius and decreases with the tube radius at fixed radius of curvature. (auth)

5478 ROTATING PLASMAS. Lehnert, B. (Royal Inst. of Tech., Stockholm). Nucl. Fusion; 11: No. 5, 485-533(Oct 1971).

A review is given of theoretical and experimental investigations on rotating plasmas. The basic equations are discussed from the microscopic and macroscopic points of view, including the balance of matter, momentum, and heat, as well as associated stability problems and limiting effects. Various types of devices are described, and obtained experimental results are compared with theoretical predictions. The review also summarizes the applications of rotating plasmas to fusion research, cosmical physics, and special technical arrangements such as plasma centrifuges, adjustable plasma condensers, and plasma gun and propulsion systems. 202 references. (auth)

5479 COLLISIONAL EXCITATION RATE COEFFICIENTS IN THE BERYLLIUM-LIKE SEQUENCE. Johnston III, William Drumm. College Park, Md.; Univ. of Maryland (1971). 87p. University Microfilms Order No. 71-24,278.

Thesis.

Relative and absolute values for electron-collisional excitation-rate coefficients to many excited levels in the beryllium-like isoelectronic sequence were measured for several ions, those for Ne VII being the most reliable. The maximum error of the absolute value of the stronger rates is estimated to be less than a factor of 3, and the few theoretical predictions available generally fall within this limit. Measurements of these coefficients have not been reported previously, and at present the experimental technique employed is the only means available for this measurement on highly ionized ions. The plasma generator was a 15-kJ theta pinch, and techniques developed earlier were used to measure line intensities and plasma parameters. The electron temperature and density were found by the light-scattering technique to be in the range 50 to 260 eV and 10^{15} to 8×10^{16} cm^{-3}, although this range was not available for each ion. (Diss. Abstr. Int., B)

5480 SOFT X RAYS FROM A LASER-HEATED DENSE PLASMA FOCUS. Shatas, Romas A.; Stettler, John D.; Meyer, Harry C.; Roberts, Thomas G. (Physical Sciences Directorate, Redstone Arsenal, Ala.). J. Appl. Phys.; 42: No. 13, 5884-6(Dec 1971).

A design analysis of a pulsed CO_2 laser-assisted plasma focus was undertaken for the purpose of enhancing the flash intensity of cold x rays when the device is operated in the x-ray generator mode. By deliberately injecting high-Z ions into the plasma the intensity of the soft x-ray component (approximately 1 keV energy) can be increased by many orders of magnitude; to compensate for the radiation loss, plasma heating by laser pulse is employed. Because the laser frequency is close to the plasma-electron Langmuir frequency, nearly all of the laser pulse energy is absorbed

in a single pass. Calculation of a typical design configuration consisting of small dense plasma focus and a 200-J electrical-discharge CO_2 laser yields laser to soft x-ray conversion efficiency of over 70%. (auth)

5481 SOLUTION OF THE BOUNDARY PROBLEM IN MAGNETOHYDRODYNAMICS BY THE HODOGRAPH METHOD. Sapunkova, O. M. Izv. Vyssh. Ucheb. Zaved., Mat.; No. 6, 78-85(Jun 1971). (In Russian).

The equations of plasma movement in a hodograph plane may be described in a symmetrical fashion. The behavior of the coefficient in such equations is examined at various values of the parameter of MHD interaction. In a sufficiently large range of hypercritical velocities, the functions φ and Ψ may be considered harmonic. Basic relationships are given for this development, namely: the problem of jet impact of an ideal plasma into a plane slab; the efflux of a jet of ideal plasma out of a plane, infinite vessel; the Khristianovich equation; approximation equations for supersonic (hypercritical) velocities; and the problem of oblique flow around a slab with disruption of the jet. (K.S.W.)

Kinetics (Experimental)

5482 MEASUREMENT OF ELECTRON-IMPACT BROADENING OF IONIZED BERYLLIUM AND BARIUM LINES IN AN ELECTRIC SHOCK-TUBE PLASMA. Platisa, M.; Puric, J.; Konjevic, N.; Labat, J. (Inst. of Physics, Belgrade). Astron. Astrophys.; 15: No. 2, 325-8(Dec 1971).

An electromagnetically driven "T" tube was the source of plasma used to measure on a shot-to-shot basis the profiles of singly ionized beryllium and barium lines. The electron density 5.40 to 2.72×10^{17} cm^{-3} was determined by laser interferometry, while electron temperatures between 16800 and 14200°K were measured from relative intensities of spectral lines. The half-widths of Ba II lines agree with the theories of Griem (1968) and Cooper and Oertel (1967) within a factor of two. The discrepancy between experimental and calculated broadening parameters for Be II lines is almost a factor of ten. (auth)

5483 COMPARISON BETWEEN THE NATURE OF BRIGHT CAPACITIVE AND DARK INDUCTIVE MICROWAVE DISCHARGES. Collet, L. H.; Catherine, Y. (Univ., Nantes, France). Compt. Rend., Ser. B; 273: No. 13, 529-32(27 Sep 1971). (In French).

The evolution of the electron densities and the electron temperature as functions of the pressure, hf excitation, and the radial position was studied in three types of hf discharges: dark capacitive, bright capacitive, and dark inductive. (France)

5484 RADIAL DISTRIBUTION OF THE LIGHT FROM AN INDUCTIVE MICROWAVE DISCHARGE IN HYDROGEN. Fourrier, C. (Univ., Nantes, France). Compt. Rend., Ser. B: 273: No. 13, 525-8(27 Sep 1971). (In French).

Changes in the radial profiles of the luminous intensity of microwave discharges were observed on increasing the hf power. The effect of a transverse magnetic field on the profiles was studied. (France)

5485 METASTABLE DENSITIES IN NOBLE-GAS PLASMAS CREATED BY NUCLEAR RADIATIONS. Guyot, J. C.; Miley, G. H.; Verdeyen, J. T. (Univ. of Illinois, Urbana). J. Appl. Phys.; 42: No. 13, 5379-91(Dec 1971).

Optical absorption measurements of metastable densities in plasmas of He, Ne, and He–Ne are reported. The plasmas were created through bombardment of the gases by the products from the boron-10 (n,α) lithium-7 nuclear reaction during irradiation by neutrons from a pulsed nuclear reactor. The experiments covered gas pressures up to 900 torr, with neutron fluxes from 10^{12} to 10^{16} n/cm^2sec. The $He(2^1S)$, $He(2^3S)$, $Ne(1s_5)$, and $Ne(1s_3)$ metastable densities were studied in the single gases and in (9/1) He–Ne mixtures. In general, the observed densities increase with pressure up to about 100 to 200 torr after which collisional losses, combined with a decrease in the source rate, eventually cause the metastable populations to fall off. The variation with neutron flux typically changes from a linear to a square-root dependence whenever the destruction by electron superelastic collisions is the dominant loss mechanism. Maximum $He(2^3S)$ and $He(2^1S)$ densities of the order of 10^{-2} to 10^{-3} and 10^{-4} to 10^{-5} $atom/cm^3$ unit flux, respectively, were measured; peak $Ne(1s_5)$ and $Ne(1s_3)$ densities were roughly 10^{-3} to 10^{-5} and 10^{-4} to 10^{-6} $atom/cm^3$ unit flux, respectively, depending on the flux level. For pressures below 20 torr, the Ne-metastable densities in the (9/1) He–Ne mixture were as much as ten times the densities in neon (at a pressure corresponding to the Ne partial pressure in the mixture). A theoretical model is presented which predicts the behavior of the metastable densities quite well, the largest discrepancy being for $He(2^3S)$ in helium. (auth)

5486 PECULIARITIES OF INTENSIVE ELECTRON BEAM FORMATION IN BOUNDED PLASMA. Suladze, K. V.; Tskhadaya, B. A.; Plyutto, A. A. (Sukhumi Physical-Technical Inst., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 6, 993-4(Jun 1971). (In Russian).

Peculiarities of formation of strong-current pulsed electron beams were studied by the method of previous filling of an accelerating gap with plasma. A distinctive feature of the method is as follows: conductivity of the gap is great and, therefore, currents of 10^4 to 10^5 A are reached in the gap for 10^{-7} to 10^{-8} sec. After reaching certain critical values of current in the gap, the ohmic resistance of the gap rises, resulting in a sharp decrease of the current and in a sharp increase of the potential difference on the gap. In this case plasma is broken into anodic and cathodic with corresponding potentials. As probe measurements showed, all the drop in voltage at the stage, when current sharply decreases, is concentrated in the plasma gap. At this stage, the electron beam is formed. The critical current value depends on plasma concentration, and at a concentration of 10^{13} cm^{-3}, it reached 5×10^4 A. In this case the beam current reached 2×10^4 A; accelerating voltage 45 kV; and current pulse duration 3×10^{-7} sec. (auth)

5487 EVIDENCE OF DENSITY INHOMOGENEITY BROADENING OF PLASMA SATELLITES FROM LIGHT SCATTERING. Chan, P. W. (Colorado State Univ., Fort Collins). Phys. Fluids; 14: No. 12, 2787-8(Dec 1971).

Light scattering from an argon plasma jet at two values of the plasma current produced evidence supporting the assumption that the linewidths of the plasma satellites reported previously are due to density inhomogeneity and not due to collisional broadening effects. (auth)

5488 ARGON AND NITROGEN PLASMA VISCOSITY MEASUREMENTS. Schreiber, P. W. (Aerospace Research Labs., Wright Patterson Air Force Base, Ohio); Hunter II, A. M.; Benedetto, K. R. Phys. Fluids; 14: No. 12, 2696-2702(Dec 1971).

The viscosities of argon and nitrogen were experimentally determined from 10,500 to 12,750°K at atmospheric pressure. The viscosity is shown to be a simple function of the velocity and the axial static pressure gradient in the arc discharge used for this experiment. A unique probe system is used to measure the difference between stagnation and static pressures across the diameter of the plasma column, and the approximate equation that converts the pressure difference to velocity is shown to be valid. The axial static pressure gradient is measured directly. Measured viscosities are compared with the experimental and calculated results of other investigators. (auth)

5489 INTERACTION OF A PLASMA FLOW WITH A MIRROR FIELD IN THE BSG-I_A DEVICE. Uchida, T.; Miyamoto, K; Fujita, J.; (and others) (Nagoya Univ., Japan). Nucl. Fusion; 11: No. 5, 441-5(Oct 1971).

The interaction of a plasma flow with a mirror field is studied by changing the mean free path of ion–ion collisions in the BSG-I_A device. In the case of a collision-dominated plasma, it was shown in the BSG-I and II devices that a shock occurs when a supersonic plasma flow encounters a mirror field. When the mean free path is made longer than the characteristic length of the mirror field, shock effects no longer occur. The diamagnetic signal in front of the mirror still increases compared with that obtained in the case without a mirror. A particle-orbit model given by Gilleo for the interaction of a plasma flow and a mirror field is refined, and the increment of the diamagnetic signal is explained by the refined model. (auth)

5490 RELAXATION OF ION BEAMS IN HOT-ELECTRON PLASMA. Kirichenko, G. S.; Khmaruk, V. G. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 645-50(Apr 1971). (In Russian).

A collisionless relaxation of the ion beam was investigated experimentally in hot electron plasma. An effective dissipation of the beam ion energy and momentum is achieved under conditions of turbulent heating of plasma electrons. (auth)

Kinetics (Theoretical)

Refer also to abstracts 5678, 5683, and 5900.

5491 (CTO–771) ASYMPTOTIC SOLUTION IN THE PROBLEM OF ANOMALOUS RESISTIVITY OF A COLLISIONLESS PLASMA. Vekshtein, G. E.; Ryutov, D. D.; Sagdeev, R. Z. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by J. B. Sykes (Culham Lab., Abingdon, Eng.), from report IYAF–97–70. 19p. Dep. NTIS (U. S. Sales Only).

The time variation of the charged-particle distribution functions in a homogeneous plasma in an external electric field E is discussed, and it is shown that, as $t \rightarrow \infty$, the distribution functions have a similarity variation, all velocities increasing linearly with time. It is found that, when the current is parallel to the external magnetic field, the directed velocity $\bar{v}$ of the electrons varies in essentially the same manner as in free acceleration: $\bar{v} = \alpha\, eEt/m$, where α is a numerical factor less than unity but of the order of unity. If the current is perpendicular to the external magnetic field, there is no "runaway", and the ratio of the directed and thermal velocities of the electrons becomes much less than unity. (auth)

5492 (INR-P-1299) SELF-CONSISTENT THEORY OF POPULATION AND IONIZATION EQUILIBRIUM AND FREE ELECTRON DISTRIBUTION. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1971. 18p. Dep. NTIS (U. S. Sales Only).

Analytical formulas are derived for population of excited levels and degree of ionization of atoms not necessarily restricted to the Maxwellian electron distribution. The results are obtained from solving Boltzmann's equation with a simplified form of the inelastic collision term. Good agreement with numerical results of other authors is obtained. (auth)

5493 (KHFTI-70-69) NONLINEAR THEORY OF RELAXATION OF MONOENERGETIC BEAMS IN PLASMA. Shapiro, V. D.; Shevchenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The dynamics of relaxation of an originally "monoenergetic" beam in a plasma was investigated. In the process of relaxation, instability plays a role in the beam particles trapped in potential oscillations. The equations obtained describe the oscillation excitation and the diffusion in the beam with respect to this instability. From these considerations the distribution function of the beam approximates a plateau in consideration of time, plasma frequency, and densities of beam and plasma. During subsequent stages of relaxation with a characteristic time, a particle acceleration appears in the beam and a velocity distribution is established that approximates a Maxwellian. (tr-auth)

5494 τ_{ef} METHOD IN THE THEORY OF RADIATION TRANSPORT. Napartovich, A. P. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 23-6 (Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 26-9(Jan-Feb 1971).

The application of the τ_{ef} method is considered for cases where the formal conditions of applicability are not met. The approximate solution is compared with the asymptotically exact one to find the error given by the τ_{ef} method. The comparison is performed for several cases and the results are presented as tables. (auth)

5495 ELECTROMAGNETIC FIELD IN ELECTRODELESS DISCHARGE. Henriksen, B. B.; Keefer, D. R.; Clarkson, M. H. (Univ. of Florida, Gainesville). J. Appl. Phys.; 42: No. 13, 5460-4(Dec 1971).

A closed-form solution is given for the electromagnetic field in a cylindrical electrodeless discharge of infinite length in which the conductivity of the plasma is assumed to be complex and have a parabolic variation with plasma radius. The low-pressure ambipolar diffusion-controlled electrodeless discharge is closely approximated by this model. Solutions are presented for various values of the ratio of collision frequency to applied frequency and for various values of plasma conductivity. The variation in magnitude of the fields within the plasma is qualitatively similar to the well-known solutions based on Thomson's model, but the phase shift is considerably reduced. (auth)

5496 CALCULATION OF PHOTON-ABSORPTION COEFFICIENT IN LASER-PRODUCED HYDROGEN PLASMAS. Tsai, Hsian-shi; Oktay, Erol; Akcasu, Ziya (Univ. of Michigan, Ann Arbor). J. Appl. Phys.; 42: No. 13, 5469-77(Dec 1971).

The absorption coefficient for ruby-laser photons in laser-produced hydrogen plasmas is calculated for temperatures up to 5×10^5°K using second-order perturbation theory. The calculations include inverse bremsstrahlung in the field of ions and excited neutral atoms and photo-ionization. The results are compared to the existing data in literature, which cover the temperature range only below 10,000°K. (auth)

5497 NONLINEAR RESPONSE OF A WEAKLY IONIZED PLASMA TO A PULSED ELECTRIC FIELD. Sodha, M. S. (Drexel Univ., Philadelphia); Kaw, P. K. J. Appl. Phys.; 42: No. 13, 5370-4(Dec 1971).

The nonlinear response of a weakly ionized gas to a moderately strong pulsed electric field (with arbitrary time dependence) was analytically investigated using the elementary theory of electrical conduction in gases. Explicit expressions are obtained for the linear and nonlinear parts of the transient current density; these are used to compute the absorption of energy in the plasma due to the pulse. (auth)

5498 PLASMA ENERGY DEPOSITION FROM NUCLEAR ELASTIC SCATTERING. Devaney, Joseph J.; Stein, Myron L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 46: No. 3, 323-33(Dec 1971).

The rate of energy loss in matter suffered by a heavy charged particle from nuclear forces elastic scattering plus nuclear Coulomb interference is derived, and the results for charge-one and -two nuclei into deuterium are given as a function of energy. (auth)

5499 CONDITIONS ACROSS NARROW TRANSITION LAYERS IN A MAGNETOPLASMA. Woods, L. C. (Oxford Univ.). Plasma Phys.; 13: No. 9, 885-6(Sep 1971).

Consideration is given to the tacit assumptions made in deriving the jump conditions at the boundary layer of a magnetoplasma, and questions arising from the neglect or introduction of surface intensities by the transition layer are examined. (UK)

5500 DIFFUSION–RECOMBINATION MODEL ON POSITIVE-COLUMN PLASMA. Toader, Emil I. (Univ., Bucharest). Rev. Roum. Phys.; 16: No. 7, 751-6(1971).

The diffusion equation is derived for the case when recombination processes play an important role in the behavior of the positive column. The recombination processes modify both the collision term and the diffusion terms. (auth)

5501 CALCULATION OF THE VELOCITY DISTRIBUTION FUNCTIONS OF ELECTRONS IN STATIONARY HOMOGENEOUS CESIUM PLASMAS. Saul, Klaus G. (Syracuse Univ., N. Y.). Phys. Fluids; 14: No. 12, 2625-31(Dec 1971).

The velocity distribution of electrons in a plasma is calculated by solving Boltzmann's equation together with the rate equations, which describe the transition rates between the different atomic levels. The calculations are made for stationary, homogeneous, cesium plasmas immersed in uniform electric fields of the order of 20 V/m. The number density of atoms is of the order of 5×10^{20} m^{-3}, and the fractional ionization ranges from zero to 10^{-2}. The processes taken into account are: elastic collisions between electrons and atoms; collisional excitations and deexcitations of atoms; radiative deexcitations of atoms; mutual electron collisions, and elastic collisions between electrons and ions. The plasmas are assumed to be optically thick at the resonance lines if the ionization degree is above 10^{-4}. The individual contribution of the elementary processes is shown by the calculation of some special cases. When all processes are taken into account, and the electron densities are high, the distributions are nearly Maxwellian. The calculations agree well with measurements of the electron temperature in the center of highly ionized positive columns. (auth)

5502 NUMERICAL STUDIES OF PLASMOID INTERACTION WITH AN AXIALLY SYMMETRIC MAGNETIC FIELD. Freeman, J. R. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Fusion; 11: No. 5, 425-31(Oct 1971).

The behavior of dense hydromagnetic plasmoids interacting with a nonuniform axially symmetric magnetic field is calculated, using a two-dimensional fully ionized two-temperature hydromagnetic model. A two-step second-order finite-difference scheme similar to the Lax–Wendroff method is used to integrate the equations. Comparisons are made with the plasmoid experiments of Azovskii et al. A good correlation is obtained for the density and induced magnetic field, although significant differences exist between computed and experimental electron temperatures. The computed results indicate that thermal conduction along field lines can be a dominant loss mechanism. (auth)

5503 VOLTAGE–CURRENT CHARACTERISTICS OF A THIN LAYER OF WEAKLY IONIZED PLASMA. Platov, Yu. V. (Inst. of Earth Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 147-9(1971). (In Russian).

The volt–ampere characteristics of a thin plasma layer were investigated by considering the space between two infinite plates as filled with a weakly ionized plasma with a given electron density. Electron–electron and electron–ion collisions were neglected because of their low concentrations; only electron–atom encounters played a role. The subsequent mathematical development utilizes particle velocities, potential differences, and distribution functions. (K.S.W.)

5504 MAGNETOHYDRODYNAMIC EQUILIBRIA FOR AN AXIALLY ASYMMETRIC FINITE-β TOROIDAL PLASMA. Matsuura, Kenya (Electrotechnical Lab., Tokyo). Denki Shikensho Iho; 35: No. 6, 576-91(May 27, 1971).

The well-known magnetohydrodynamic equilibrium equations are reduced to equations of convenient forms for the purpose of an investigation into equilibria of an axially asymmetric toroidal plasma with a diffuse boundary by introducing two scalar functions corresponding to a stream function in an axially symmetric case. In the reduction, it is assumed that the toroidal effects are small; namely, the quantities of the configurations are expanded by using the ratio of the minor radius to the major one in the toroidal system. Two cases of bumpy and helical-type configurations are considered. In the former case, the resultant solutions give pictures of the bumpy-type configuration which has helical character due to the toroidal effect. The helical-type configuration no longer has helically symmetric structure because of its toroidal effect. (auth)

5505 CALCULATED CONTINUOUS EMISSION OF AN LTE HYDROGEN PLASMA. Roberts, J. R.; Voigt, P. A. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75A: No. 4, 291-8(Jul-Aug 1971).

The total continuous emission coefficient for an LTE hydrogen plasma at one atmosphere is calculated for a temperature range from 8000 to 16000 K and a wavelength range from 400 to 15000 Å. Contributions involving the species H, H_2^+, H^-, and H_2, as well as the wings of Stark-broadened hydrogen lines are included. This calculation will permit the radiation emitted from a laboratory hydrogen plasma to be used as a high-intensity spectral radiance calibration standard. (auth)

5506 DRESSED-PARTICLE DESCRIPTION OF EQUILIBRIUM QUANTUM PLASMA AT FINITE TEMPERATURE. Mandel, P. (Univ. Libre, Brussels). Physica; 54: No. 2, 241-60(31 Aug 1971).

The transformation theory developed by the Brussels school is applied to equilibrium quantum plasmas at finite temperature. As a consequence, a description of the plasma in terms of dressed particles is possible. The following properties are seen to hold: (1) the distribution function $\tilde{\varphi}(v)$ of the dressed particles is a Fermi distribution; (2) the entropy may be written as the entropy of independent dressed particles; and (3) the total energy is related to $\tilde{\varphi}(v)$ through the same variational dependence as in Landau's theory of the Fermi liquid. (auth)

5507 RELAXATION OF THE ELECTRON VELOCITY DISTRIBUTION IN A TIME-DEPENDENT WEAKLY IONIZED PLASMA. Polman, J. (Philips Research Labs., Eindhoven, Netherlands). Physica; 54: No. 2, 305-17(31 Aug 1971).

The time-dependent Boltzmann equation for electrons in a weakly ionized plasma, subject to a suddenly applied electric field, is solved numerically. The solution gives the relaxation of the electron velocity distribution towards the equilibrium, belonging to the value of E. It is found that the number of electrons in the tail of the distribution is larger during the heating process than in a steady state with the same average energy. This is caused by a forced drift in velocity space and increases the rate of excitation of atomic levels (up to a factor of 10, depending on the parameters used). The results of the computations may play a role in the explanation of the enhancement of the light emission by pulsing a low-pressure arc discharge with a period between the diffusion time and the energy relaxation time of the electrons. (auth)

5508 HOLTSMARK-CONTINUUM MODEL FOR THE STATISTICAL DESCRIPTION OF A PLASMA. Dalenoort, G. J. (EURATOM-FOM, Jutphaas, Netherlands). Z. Phys.; 248: No. 1, 22-40(1971).

A new model is introduced for the statistical description of an ionized gas, which on the one hand combines the favorable features of the Holtsmark model and, on the other hand, those of the continuum model. The model enables the calculation of single and of joint probability distributions of microscopic quantities, the latter as a function of time intervals. Also, the corresponding correlation functions as well as some numerical results are presented. A comparison with some other models is made, and the limitations of this model are given. (auth)

5509 NONEQUILIBRIUM DENSITIES OF INHOMOGENEOUS PLASMAS WITH PHOTOABSORPTION. Froehlich, G.; Sewing, K. H. (Univ., Stuttgart). Z. Phys.; 248: No. 1, 61-80(1971). (In German).

The electron and population densities in nonequilibrium plasmas are computed. For these computations, rate equations dependent on geometrical dimensions were used. Such rate equations result if the unknown radiation intensity is eliminated. This is achieved by using the radiative transport equation. The density computations are valid for a quasi-neutral plasma. The total pressure or the density of the heavy particles and the distribution of the electron energy have to be assumed. For homogeneous plasmas the inelastic collision processes and the radiation processes are considered. For inhomogeneous plasmas the diffusion processes of the excited atoms are considered in addition to the collision and radiation processes. Using this method of calculation the electron and population densities of a cesium plasma are computed. Maxwellian distributions and a total pressure of 1 torr are assumed. (auth)

5510 POLARIZATION INTERACTION OF COAXIAL PLASMA STREAMS IN THE MAGNETIC FIELD OF TOROIDAL SOLENOID WITH A DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 579-84(Apr 1971). (In Russian).

It is shown that polarization interaction of coaxial plasma streams in the toroidal magnetic field with a divertor results in an effective trapping of axial plasma streams inside a hollow plasma cylinder. (auth)

5511 ELECTRON CORRELATIONS IN A CLASSICAL PLASMA. Pathak, K. N.; Aggarwal, K. G. (Panjab Univ., Chandigarh, India). pp 77-80 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

The particle correlations in a system of negatively charged particles imbedded in a static uniform background of positive charge are considered for the case of lower temperatures and higher densities. Ichimaru's solution (Phys. Rev. 2: 494(1970)) of the BBGKY equation is used. It is shown that G(q) varies as q and $\{S(q) - 1\}$ varies as 1/q for large values of q. (D.L.C.)

Production

Refer also to abstracts 5496 and 5534.

5512 (AEC-tr-7281) SOME PECULIARITIES IN PLASMA FORMATION BY MICROWAVE DISCHARGES NEAR HARMONICS OF ELECTRON CYCLOTRON FREQUENCY. Budnikov, V. N.; Novik, K. M.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad, Fiziko-Tekhnicheskii Institut). Translation of report NP-18503. 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 1217. (M.O.W.)

5513 (FRNC-TH-103) ELECTROMAGNETIC RADIATION COHERENCE ROLE IN GAS PHOTOIONIZATION AND RADIATION SCATTERING IN FOCUSING A LASER BEAM. Millet, Jean (Aix-Marseilles Univ. (France). Faculte des Sciences). 1970. 103p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Two phenomena associated with the laser-beam breakdown of gases were theoretically studied: multiphoton absorption and laser scattering. A multiphoton effect theory, constructed from Feynman diagrams, describes the effect of the statistical properties of the radiation on this phenomenon. Pure coherent and incoherent electromagnetic fields were compared. The Thomson scattering cross section was calculated; the scattered radiation statistics and their connection with density fluctuations were studied. The main characteristics of the plasma can be determined experimentally by studying the frequency spectrum of the scattered light. Experiments for measuring the transition probability in the multiphoton effect with a cesium jet and experiments for studying the laser radiation scattering spectrum by an afterglow plasma are being undertaken. (France)

5514 (IAE-2008) PLASMA COMMUTATOR FOR HIGH-POWER PULSED CIRCUITS. Komel'kov, V. S.; Modzolevskii, V. I. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method is described for closing a circuit of high-power pulsed equipment by means of a high-density plasma jet moving at 2 to 3 km/sec. The jet is generated in air, at atmospheric pressure, by operating currents flowing in a commutated circuit. The circuit-closing time may be varied between 1.5 to 20 μsec by means of a current change in the circuit and the distance of the closing interval. During commutation in the first half-period (T/4 and T/2), the spread in closing time amounts to $\pm$0.3 to 0.4 μsec. The commutator is of simple construction and may be utilized in a wide variety of experimental and industrial situations. (tr-auth)

5515 LASER GENERATION OF RAREFIED PLASMA FLOWS. Koopman, David W. (Univ. of Maryland, College Park). pp 177-96 of Modern Optical Methods in Gas Dynamic

Research. /Dosanjh, Darshan S. (ed.). New York; Plenum Publishing Corp. (1971).

From Symposium on modern optical methods in gas dynamic research; Syracuse, N. Y. (25 May 1970).

A focused pulse from a Q-switched laser incident on a solid target is used to generate a plasma which expands into a vacuum of low-density background gas. In a typical situation, conditions measured 33 cm from an aluminum target are: flow velocity U = 10^7 cm/sec, $n_e = \Sigma n_i Z_i = 5 \times 10^{11}/cm^3$, $T_e = 3$ eV, $U^2/2 = 2$ keV, $T_i \leq 10$ eV, $\lambda_{ii} \sim 10$ cm, and Debye distance $\lambda_D \sim 10^{-3}$ cm. These properties have been measured with Langmuir probes and microwave interferometers incorporating Lecher-wire elements. Applications of this technique of plasma flow generation to investigations of probe response in flowing plasmas and to studies of collisionless counterstreaming plasma instabilities are described. (auth)

5516 PULSED HIGH-PRESSURE PLASMATRON. Rutberg, F. G.; Levchenko, B. P. High Temp. (USSR) (Engl. Transl.); 9: No. 1, 193-6(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 215-18(Jan-Feb 1971).

An electric arc heater operating in a pulsed mode is discussed. The construction developed is designed for obtaining high-enthalpy plasma streams having an outflow time of 10^{-3} to 10^{-1} sec. The proposed magnitude of the energy applied to the gas reaches 10^7 J. Oscillograms of the voltage, current, and pressure as functions of gas density are given. (M.O.W.)

5517 PARAMETERS OF A PLASMA SOURCE WITH AN ARC STABILIZED BY A SUPERSONIC AIRSTREAM. Konotop, V. A.; Blokhin, V. I. High Temp. (USSR) (Engl. Transl.); 9: No. 1, 146-9(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 174-7(Jan-Feb 1971).

A brief description is given of the plasma source, with voltage–current curves and observed enthalpies for the jet center as a function of the specific power input for various throat lengths in the stabilizing nozzle. Measurements are reported for the potential along the arc and the heat flux in the wall of the nozzle. (auth)

5518 STRUCTURE OF THE PLASMA FIREBALL PRODUCED BY A CO_2 LASER. George, E. V. (Massachusetts Inst. of Tech., Cambridge); Bekefi, G.; Ya'akobi, B. Phys. Fluids; 14: No. 12, 2708-13(Dec 1971).

The space and time resolved structure of a helium plasma produced with a repetitive CO_2 laser is studied during the first 15 μsec of the afterglow period. The spectra of several neutral and ionized helium lines are used in the determination of the density and temperature profiles of the luminous fireball. It is found that the plasma is composed of a dense, hot core that emits primarily ionic lines, and a well-defined tenuous outer shell that is primarily the source of neutral emission lines. This "two-component" plasma structure develops at ~0.4 μsec after breakdown, at about the time when the luminous fireball dissipates its expansion energy and comes to a virtual standstill. (auth)

5519 STIMULATED SCATTERING AND SELF-FOCUSING IN LASER-PRODUCED PLASMAS. Palmer, A. J. (Memorial Univ. of Newfoundland, St. John's). Phys. Fluids; 14: No. 12, 2714-18(Dec 1971).

Calculations are presented of the threshold conditions for the onset of stimulated scattering processes and self-focusing within a fully ionized, laser-produced, spark plasma, using a linearized theory. Plasma density fluctuations induced through ponderomotive forces and thermal deposition are found to give rise to net gains for stimulated Thomson scattering for a realizable set of values of plasma parameters and laser power. Also, the results for the self-focusing thresholds are consistent with previously reported conditions for observing filamentation in laser-induced, gas breakdown plasmas. (auth)

5520 ONE-DIMENSIONAL INTERACTION OF A PLASMA WITH A RUBY-LASER BEAM. Engelhardt, A. G. (Institut de Recherche de l'Hydro, Quebec). J. Appl. Phys.; 42: No. 13, 5492-4(Dec 1971).

Analytical and experimental studies were made of the plasma ejected from a solid metallic surface as the result of impinging Q-switched ruby-laser radiation when the laser power density P_A exceeds 10^9 W cm^{-2}. Based on the one-dimensional equations of motion and conservation of energy, the model predicts the quantity and temperature of ejected plasma. To check the theory, pure copper and aluminum disks were irradiated by a Q-switched ruby laser for $3 \times 10^{10} \leq P_A \leq 2 \times 10^{11}$ W cm^{-2} and $30 \leq \tau_L \leq 50$ nsec, where τ_L is the pulse width. From framing-camera pictures taken up to 550 nsec after plasma creation, the expansion velocity of the plasma was measured and agreed acceptably well with that predicted by theory. (auth)

5521 INJECTION OF LASER PLASMA INTO A STELLARATOR. Andryukhina, E. D.; Blanken, R.; Voronov, N. P.; (and others) (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 5, 210-12(5 Sep 1971).

[25]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 317-20(5 Sep 1971).

A study was made of the main laws governing the parameters of a captured laser plasma injected into the closed magnetic trap TOR-1. The high efficiency of capture is demonstrated. The following parameters were studied: plasma density, electron temperature, the potential of the captured plasma, the pressure on the laser energy, the dimensions of the focal spot, the position of the target, and the magnetic field intensity. (M.O.W.)

5522 EFFECT OF A 400-kOe MAGNETIC FIELD ON A LASER-SPARK PLASMA. Kaitmazov, S. D.; Medvedev, A. A.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 5, 208-10(5 Sep 1971).

[25]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 314-16(5 Sep 1971).

An investigation was made of laser breakdown in fields stronger than 400 kOe. Optical breakdown was produced with a neodymium laser operating either in the mode locking or in the Q-switching regime. The spark was produced in air at atmospheric pressure and at a laser energy 2 to 3 J. Spark photographs were obtained and are discussed. (M.O.W.)

Stability

5523 (IPP–1/121) DYNAMIC STABILIZATION OF THE HELICAL m = 1 INSTABILITY ON A LINEAR SCREW PINCH. Gruber, Otto (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1971. 60p. (In German). Dep. NTIS (U. S. Sales Only).

Dynamic stabilization of the helical m = 1 instability was studied in the linear high-β screw pinch ISAR III ($T_i \approx 50$ to 200 eV; $n_e \approx 5 \times 10^{16}$ cm^{-3}; $\beta \geq 0.5$). The experimentally determined growth rates ω_i (0.5 to 3×10^6 s^{-1}) and wavelengths (100 to 200 cm) of these modes are about the same as in a toroidal screw pinch and both agree well with theory. Two methods of dynamic stabilization were investigated. In both cases the stabilizing effects were better than expected from theory. In the first method an axially uniform oscillating field $\tilde{B}_{z0} \cdot \sin(\omega_s t)$ was superposed on the quasi-steady B_{z0} field ($\omega_s > \omega_i$). The m = 1 mode is stabilized and a stabilization condition $\tilde{B}_{z0}/B_{z0} \gtrsim 2\ \omega_i/\omega_s$ holds. This stabilizing effect is very likely caused by inertial forces produced by enforced m = 0, k = 0 oscillations of the plasma column. Working in resonance with the natural plasma oscillations the condition above is easier to fulfill. In the second method only oscillating currents $\tilde{I}_{z0} \cdot \sin(\omega_s t)$ were added to the axial plasma current I_{z0} to study the stabilization by dynamic shear ($\omega_s > \omega_i$). Magnetic probe measurements showed that the $\tilde{I}_z$ flows in the dilute plasma outside the dense plasma column. The measured skin depths and resistivities are larger than those expected from classical theory. Nevertheless, a reduction of the growth of the m = 1 mode occurred that was higher the more $\tilde{I}_z$ flowed close to the plasma column, giving a stabilization condition $\tilde{I}_{z0}/I_{z0} > \omega_s/5\omega_i$. (auth)

5524 ACOUSTIC INSTABILITY OF CURRENT-CARRYING PLASMA. Glushkov, I. S.; Kareev, Yu. A. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 1-10(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 1-11(Jan-Feb 1971).

Linear theory is used in an investigation of the stability of current-carrying plasma with respect to acoustic oscillations. Joule heat fluctuations can excite two types of instabilities in such plasma: wave instability and aperiodic instability; in a real plasma these instabilities can exist either simultaneously or separately. Conditions are derived under which either type of instability can arise. An expression is derived for determining the dimension of the volume in which plasma is stable to aperiodic disturbances. Numerical results are in good agreement with experimental data. (auth)

5525 HYDRODYNAMIC INSTABILITIES OF CURRENT-CARRYING PLASMA IN A TRANSVERSE MAGNETIC FIELD. Pashkin, S. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 11-19(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 12-21(Jan-Feb 1971).

The two-fluid model of a plasma in crossed E and B fields is used to study possible types of hydrodynamic instability. A dispersion equation is derived which exhibits ionization, acoustic,

and superheating instability. Superheating instability is investigated in detail, and the corresponding topology boundaries, and increment are determined. It is shown that it can play an important role in open-cycle magnetohydrodynamic devices. A simple expression is obtained for the rate of ionization of striations with the influence of the magnetic field taken into account. The conclusion that ionized striations will, under certain conditions, move against the current, is confirmed by experimental results. Conditions for the existence of each type of instability and the interactions between different instability types are determined. (auth)

5526 TWO-STREAM INSTABILITIES. Briggs, Richard J. (Massachusetts Inst. of Tech., Cambridge). Advan. Plasma Phys.; 4: 43-78(1971).

The following chapters on two-stream instabilities are included: (1) the multistream model, (2) interaction of a low-density beam with a stationary plasma, (3) finite systems; infinite magnetic field, and (4) finite systems; and zero magnetic field. 37 references. (M.O.W.)

5527 OBSERVATIONS OF THE BEAM–PLASMA INSTABILITY. Gentle, K. W.; Roberson, C. W. (Univ. of Texas, Austin). Phys. Fluids; 14: No. 12, 2780-2(Dec 1971).

The nonlinear limit of the instability driven by a low-density cold-electron beam in a collisionless plasma is experimentally found to be determined by the trapping of the beam by the most rapidly growing wave. (auth)

5528 FLUTELIKE MICROINSTABILITIES IN MIRROR-CONFINED PLASMAS WITH BROAD $v_\perp$ DISTRIBUTIONS. Young, T. S. T.; Callen, J. D.; McCune, J. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 14: No. 12, 2783-5(Dec 1971).

It is demonstrated that it is the width of the positive derivative region of the $v_\perp$ distribution function that determines whether the flute-like microinstabilities of a magnetized plasma occur at high densities. (auth)

5529 ION-WAVE CURRENT INSTABILITIES AND ANOMALOUS RESISTIVITY. Kan, J. R. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids; 14: No. 12, 2740-7(Dec 1971).

A theory of ion-wave current instabilities which takes into account, in a self-consistent manner, the inhomogeneities generated by field-aligned currents in a collisionless plasma is presented. Diamagnetic current associated with the current-produced density gradient is included in the distribution. The theory predicts that for a given frequency, the current threshold for ion-wave current instabilities is, in general, much below the threshold of ion acoustic instability in a uniform plasma as given by Fried and Gould. The current threshold is essentially zero in the limit when the ion Landau damping effect is negligible, or equivalently, the ion-wave current instabilites are absolute if there are no limitations on the wave-length. This is true even in the absence of externally applied density gradients in contrast to Kadomtsev's drift-wave results. For dimensions of interest in laboratory plasmas, the predicted linear growth rate increases with increasing longitudinal wavelength and with decreasing wavelength parallel to the diamagnetic current. Under the conditions of an experiment on anomalous resistivity (the dimensions but not the geometry of the machine have been considered), there is good agreement between the predicted onset of ion-wave current instabilities and the experimental data on the onset of anomalous resistivity. (auth)

5530 INSTABILITY OF A DENSE PLASMA OF HIGH-CURRENT PULSED DISCHARGES. Nikolaev, F. A.; Rozanov, V. B.; Sviridenko, Yu. P. Kratk. Soobshch. Fiz.; No. 4, 59-65 (Apr 1971). (In Russian).

Intensely radiating discharges are examined within the framework of magnetohydrodynamic theory, with the inference that there emerges a powerful and discontinuous instability that plays an essential role in the development of such discharges. Theoretical results are compared with already-published experimental values. The dynamics of the development of powerful pulsed discharge in a dense plasma leads to instability and to a complex formation of the discharge. (K.S.W.)

Thermonuclear Processes

Refer also to abstract 5158.

5531 (LA–4814) RADIATION AND WALL FLUX CALCULATIONS FOR A THETA-PINCH SCIENTIFIC FEASIBILITY EXPERIMENT AND A PROTOTYPE REACTOR. Burnett, S. C.; Ellis, W. R. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 14p. Dep. NTIS.

Projected parameters for the next two generations of high-beta theta-pinch devices are summarized: (1) a toroidal scientific feasibility experiment and (2) a prototype pulsed D–T reactor. These parameters are used to calculate reaction rates and the energy densities of charged particles, neutrons, and photons in the plasma. The effect of alpha-particle heating on the plasma parameters is taken into account for the reactor. The corresponding fluxes to be expected on the first-surface vacuum wall are calculated. The feasibility experiment would be primarily an experimental device, as opposed to the prototype reactor, which must be engineered to operate satisfactorily on a repetitively pulsed basis. A simple model of energy balance for the reactor is used to estimate the thermal and electrical power output. (auth)

5532 (LA–4815) THE $l_{1,0}$ COIL SYSTEM FOR SCYLLAC AND SCYLLA IV. Borkenhagen, W. H.; Ellis, W. R.; Harris, H. W.; Zimmermann, E. L. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 12p. Dep. NTIS.

The system of auxiliary l = 1 and l = 0 coils for the Scyllac and Scylla IV θ-pinch experiments at LASL is described in detail, including theory of operation, design constraints, voltage and current requirements, methods of fabrication and testing, and external electrical circuits. These coils produce magnetic fields of the general form sin (lθ-hz) which, when added to the axial θ-pinch field B_0, provide toroidal equilibrium for the plasma column and a means of feedback stabilization. Because these coils are subjected to both induced and applied voltages, the major engineering effort has been directed toward achieving adequate electrical insulation in the limited space demanded by the low-inductance circuitry. Sophisticated epoxy potting, taping, and spacing techniques have been required. DC and pulsed voltage tests to above 100 kV have been conducted prior to installation of the coils on the experiments. Electrical connections are made outside the θ-pinch coil in such a way as to cancel the induced voltages before they can reach the driving capacitor banks. (auth)

5533 (UCRL–73242) SUPERCONDUCTING LEVITRON RING POSITION CONTROL SYSTEM. Rossow, Terry L.; Taylor, Clyde E.; Branum, David R. (California Univ., Livermore. Lawrence Radiation Lab.). 7 Jun 1971. 7p. (CONF-711111–14). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A superconducting ring was levitated by a magnetic field, using active negative feedback to stabilize the ring position. (auth)

5534 FLOWS WITH RADIANT ENERGY ABSORPTION AND THERMONUCLEAR REACTIONS BEHIND THE SHOCK WAVE. Rosciszewski, Jan; Su, Fa Yan (Air Vehicle Corp., San Diego, Calif.). Phys. Fluids; 14: No. 12, 2762-6(Dec 1971).

Results of numerical calculations of the flow field behind the shock wave with intense laser radiation absorption and laser-triggered thermonuclear reactions are presented. It is shown that, in the case of absorption coefficient increasing with temperature (high Z materials), absorption after a certain time leads to a detonationlike phenomenon. In the case of laser-triggered d–t thermonuclear reaction it is shown that maximum energy release occurs in the distance of one-half the absorption mean free path, and in the one-dimensional case the reaction rate grows to infinity if the initial shock and the laser pulse are strong enough. (auth)

5535 TRIGGER CRITERION FOR STEADY FUSION DETONATIONS IN D–T ICE. Ahlborn, B. (Univ. of British Columbia, Vancouver). Phys. Lett.; 37A: No. 3, 227-8(22 Nov 1971).

A plane and steady fusion detonation in D–T ice may be ignited with a power density of 7×10^{15} W/cm^2 and an energy density of 6×10^9 J/cm^2, releasing a total of 6×10^{18} W/cm^2 at a temperature of 5 keV. (auth)

5536 SOME FACTORS IN THE CHOICE OF D–D, D–T, OR D–^{3}He MIRROR FUSION POWER SYSTEMS. Heckrotte, W.; Hiskes, J. R. (Univ. of California, Livermore). Nucl. Fusion; 11: No. 5, 471-84(Oct 1971).

Relative merits of the D–D, D–T, or D–^{3}He mirror fusion power systems are discussed. As a basis for discussion a simple approach was used for estimating the ratio of Q(D,He) to Q(D,T). When needed, the value of Q(D,T) is considered to be of the order of that calculated by Marx and by Kuo–Petravic, Petravic, and Watson. The systems are compared at different assumed plasma temperatures in the range 200 to 1000 keV on the basis of several criteria: the investment costs in dollars per kilowatt, the ratio of waste power to power output, and the tritium and neutron production. It is concluded, based on the estimates of the ratio of Q values, that subject to these criteria the D–T system appears the

more favored system. On the other hand, should a means be found to enhance the Q values, the D–^{3}He system would be preferred on all but the first criterion. The three-component D–T–^{3}He system and its optimization are considered. Finally, the possibility of further enhancing the D–T system by utilization of tritium breeding in the plasma is discussed. (auth)

5537 ENHANCED REACTION CROSS-SECTION OF POSSIBLE CTR INTEREST: ^{9}Be + p. Elwyn, A. J.; Monahan, J. E.; Schiffer, J. P. (Argonne National Lab., Ill.). Nucl. Fusion; 11: No. 5, 551-2(Oct 1971).

It has been suggested that the discovery of a low-energy nuclear resonance reaction yielding energetic charged particles might be important in the development of a "clean" controlled thermonuclear reactor. A survey of known levels in light nuclei indicates that the p + ^{9}Be reaction most nearly satisfies the requirements. (R.W.R.)

5538 AUTOCATALYTIC BURNING OF ^{6}LiD NUCLEAR FUEL VIA THE p + ^{9}Be RESONANCE REACTION. McNally, J. R. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 11: No. 5, 554-6(Oct 1971).

The p + ^{9}Be reaction has a very strong resonance with the 6.88-MeV ^{10}B* state at E_p = 330 keV. This resonance reaction would utilize very efficiently the slowed-down protons from injection or fusion chain reactions; in addition, it leads to nonradioactive charged particles. The d and ^{6}Li produced are energetic fuel nuclei; this may help resolve the problem of heating ^{6}LiD fuel to reaction energies. Thus, autocatalytic burning can result. (R.W.R.)

5539 MAGNETIC FIELD STRUCTURE OF THE URAGAN-1M STELLARATOR. Georgievskii, A. V.; Dikii, A. G.; Ziser, V. E.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 680-2(Apr 1971). (In Russian).

The spiral cylinder of the stellarator "Uragan" had been the source of considerable disturbance to the magnetic surfaces. Accordingly, the cylinder was replaced by a linear cylinder of given parameters, and data are reported that show the improved performance of this design. (K.S.W.)

5540 ZAMKNUTYE PLAZMENNYE KONFIGURATSII. (Closed Plasma Configurations). Artsimovich, L. A. Sovremennye Problemy Fiziki. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1969). 160p.

The author's lectures, presented at Saclay, France in 1967–1968, form the basis for this small text. Basic questions are examined: the geometry of magnetic fields and the physical processes and equilibrium conditions that stabilize plasmas. Experiments that have been conducted in thermonuclear laboratories are analyzed. Various types of thermonuclear installations designed to study high-temperature plasmas are discussed. Complex mathematical apparatus is avoided; attention is focused on the physical mechanisms involved. (tr-auth)

5541 NUCLEAR FUSION REACTOR: ITS CONCEPT AND PROBLEMS. Mori, Shigeru; Ota, Mitsuru; Nagasaki, Ryukichi; Hiraoka, Tooru; Amano, Hiroshi (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 5, 275-95 (May 1971). (In Japanese).

Components of fusion reactors are illustrated. Safety of the reactors was investigated. Plasma conditions to be fulfilled during reactor operation were surveyed. Balance of particle density, balance of energy, Lawson's condition, and stability of core plasma are considered. Materials for plasma containers were studied, and alloys of molybdenum or niobium were considered. The role and composition of blankets are explained. Behavior of the 14-MeV neutrons in the blanket is also explained. The method and problems concerning tritium collection are discussed. Finally, examples of reactor design are shown. Present status of the study of fusion reactors is reviewed. (Japan)

Wave Phenomena

5542 (AEC-tr-7278) LINEAR TRANSFORMATION AND ABSORPTION OF WAVES IN PLASMA. Golant, V. E.; Piliya, A. D. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-18504. 70p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 1243. (M.O.W.)

5543 (DEMO-71/21) DISPERSION RELATIONS IN A MAGNETOELECTRIC MEDIUM (STATISTICAL PLASMA). Nicolis, J. S.; Athanassoula-Georgala, E. (Democritus Nuclear Research Center, Athens (Greece)). Oct 1971. 20p. Dep. NTIS (U. S. Sales Only).

Dispersion relations are derived for plane electromagnetic wave propagation in a homogeneous charge-equilibrated electron gas characterized by a continuous (isotropic) velocity distribution $f(\bar{v})$. The dispersion curves $k = f_0(\omega, k, v, \theta)$ are studied as a function of the upper bound velocity v_{max} and θ, the angle between $\bar{k}$ and $\bar{v}$, for an electron distribution function which is constant in a bounded region of phase space and zero outside this region ("water-bag" model). (auth)

5544 (N-71-33445) RESEARCH PROGRAM IN PLASMA PHYSICS. Final Report. (Avco-Everett Research Lab., Everett, Mass.). Mar 1971. Contract NASw-2040. 19p. (NASA-CR-121437). NTIS.

Results of a plasma physics research program on collisionless shock waves and barium cloud dynamics are reported. Several factors that influence the linear stability of barium ion clouds were investigated, including the stability as a function of position around the cloud and the stabilization provided by the presence of a conducting E region. Some analytic work on the nonlinear equations provided some insight into the steepening of the backside of barium ion clouds and the development of magnetic-field-aligned sheets hanging back from the ion cloud in the direction of the neutral cloud. An annotated bibliography of the work done is given and two reports, Plasma Cloud Striations and Collisionless Shocks in Plasmas, containing the principal results of this research are included. (auth) (STAR)

5545 (N-71-33500) COMMENTS ON ION-ACOUSTIC SOLITARY WAVES IN PLASMAS. Wu, C. S.; Taussig, R. T.; Chu, C. K. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). 1971. Contract AT(30-1)-3954. 9p. (NASA-CR-121448). NTIS.

It was first shown by Sagdeev that ion sound solitary waves can occur in a plasma with cold ions and hot electrons. Later Washimi and Tanuiti showed that the Korteweg–deVries equation can be derived for the problem of ion sound wave disturbances moving with velocity slightly greater than the ion sound speed in a homogeneous plasma free of external field. Consequently, steady-state solution for ion sound solitary waves was again demonstrated. The theoretical prediction of the existence of ion sound solitary waves has attracted a great deal of attention in recent years since the subject is highly relevant to the theory of collisionless shock waves. Some basic conceptual difficulties associated with these earlier derivations are discussed, and a more accurate picture of the essential physics involved is proposed. (auth) (STAR)

5546 (NP-19072) NONLINEAR EFFECT IN MICROWAVE ABSORPTION BY PLASMA. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some data on microwave absorption by plasma concerning nonlinear effects at sufficiently high microwave power are reported. The experimental conditions were: a discharge tube 70 cm long and 2.5 cm in diameter was placed in a uniform magnetic field; the operating gas was argon at 10^{-2} mm Hg; plasma density was 10^{11} to 10^{12} cm^{-3}; and plasma temperature was 3 to 10 eV. The discharge was maintained by absorption of 10-cm 150-W microwave power at magnetic fields higher than the cyclotron value, $H > H_c = mc\omega/e$, $\omega < \omega_{H_c} = eH/mc$. It was found that at power levels exceeding critical ones the microwave absorption also took place outside the transformation region. On increasing the power levels, the gap between the high-frequency transformation region and the middle one was narrowed and then closed. The phenomenon described can be accounted for by a decay instability. (auth)

5547 (NP-19073) CHARACTERISTICS OF FORMATION OF MICROWAVE DISCHARGES IN PLASMA AT MAGNETIC FIELDS HIGHER THAN THE CYCLOTRON FIELD. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A microwave discharge formed at magnetic fields higher than the cyclotron value far from the absorption boundary was studied: $H > H_c = mc\omega/e$, $\omega < \omega_{H_c} = eH/mc$. An argon plasma at pressure 10^{-1} to 10^{-3} mm Hg was created by 10-cm microwaves. The quartz discharge tube was 70 cm long and 2.5 cm in diameter and placed in a 10-cm waveguide. Some lines in the absorption region of a parametric space were discovered. The location of the lines is described by equations of the one-dimensional wave transformation theory similar to those describing the transformation boundary. (auth)

5548 (NP-19076) WAVE PENETRATION INTO A PLASMA AT LOW HYBRID FREQUENCIES. Golant, V. E. (Akademiya

Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 30p. (In Russian). Dep. NTIS (U. S. Sales Only).

The penetration of electromagnetic waves into a low hybrid resonance region in magnetized plasma is discussed. The conditions of wave penetration in uniform and nonuniform magnetic fields are analyzed. The efficiency of wave input for these conditions is calculated. (auth)

5549 CONSISTENT SOLUTION OF THE UNDAMPED CY CYCLOTRON-WAVE PROPAGATION PROBLEM. Schram, D. C. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica; 54: No. 2, 325-8(31 Aug 1971).

In a previous article (Physica, 40: 422-34(Dec 30, 1968)) the author treated the problem of the nonlinear dielectric behavior of a cold plasma drifting along a static magnetic field in a large-amplitude EM wave near and at cyclotron resonance. In that article, expressions for the reactive currents as functions of the permittivity, and close to the resonance, were developed. A rather cumbersome numerical procedure was involved in obtaining the characteristic quantities; this note presents an alternative, approximate procedure that results in generalized expressions for all quantities. (L.M.T.)

5550 ANOMALOUS RESISTIVITY AND ION-ACOUSTIC TURBULENCE. Manheimer, Wallace M. (Naval Research Lab., Washington, D. C.); Flynn, Robert. Phys. Rev. Lett.; 27: No. 18, 1175-9(1 Nov 1971).

Anomalous resistivity and steady-state turbulent spectra were evaluated for ion-acoustic waves driven unstable by an electron drift. The model assumes that long-wavelength unstable waves couple to short-wavelength damped waves to reach a steady state. The anomalous resistivity turns out to be a very rapidly increasing function of the electron drift velocity. (auth)

5551 DISPERSION CHARACTERISTICS OF ELECTROMAGNETIC CYCLOTRON HARMONIC WAVES IN WARM PLASMAS. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C.). J. Appl. Phys.; 42: No. 13, 5418-21(Dec 1971).

A discussion is given on the dispersion properties of the electromagnetic ordinary wave propagating perpendicular to a uniform magnetic field in collisionless warm plasmas. In addition to the cold-plasma prediction that the wave is propagating when its frequency exceeds the plasma frequency, the Vlasov theory predicts the existence of propagation bands in the neighborhoods of the harmonics of the cyclotron frequencies. Detailed results are given for the first three electron cyclotron harmonics. It is found that the bandwidths increase with $\beta_{||}$ and $T_{||}/T_{\perp}$, where $\beta_{||}$ is the parallel electron thermal pressure to magnetic pressure and $T_{||}$ and $T_{\perp}$ are the electron temperatures parallel and perpendicular to the field, respectively. For $\beta_{||}$ values of unity or higher, the propagation band around the first harmonic is sensitively dependent on the ratio $T_{||}/T_{\perp}$. In the limit of $T_{\perp} \to 0$ but $T_{||}$ remaining finite, the second and higher harmonics vanish while the first harmonic can extend to a small fraction of the cyclotron frequency. (auth)

5552 PLANE WAVE INTERACTION WITH AN INHOMOGENEOUS WARM PLASMA COLUMN. Parbhakar, K. J.; Gregory, B. C. (Univ. of Quebec, Varennes). Can. J. Phys.; 49: No. 20, 2578-88(15 Oct 1971).

The interaction of a plane electromagnetic wave with an inhomogeneous warm plasma column is studied as a boundary value problem using a wave matching method. The plasma is characterized by a uniform electron temperature T and a parabolic density distribution $N_{00}(1 - \alpha r^2/a^2)$, where N_{00} is the central line density, α the inhomogeneity parameter, and a the column radius. The coupled Maxwell's and first two moment equations, assuming scalar pressure, are solved numerically without the quasi-static assumption. The resonances cannot be characterized by a single parameter; the effects of α, T, and N_{00} are studied separately. The resonances are located by noting that the magnitude of the scattering coefficient is unity (for a unit amplitude incident wave) at resonance. The maxima in the scattering are associated with the maxima in the coupling. It is found that the dielectric or the main resonance is a reasonably good radiator, while the plasma wave resonances (Tonks–Dattner resonances) are rather poor radiators. A detailed analysis of the radial electric field inside the plasma indicates that the main resonance is essentially a cold plasma resonance. As for the resonant frequencies, the results are in good agreement with those of Parker, Nickel, and Gould. The radial electric field at resonance inside the plasma is very sensitive to electron temperature. For the main resonance the field distribution at low electron temperature approaches that of a uniform cold plasma at resonance. (auth) (Canada)

5553 PLASMA COLLECTIVE MODES INVOLVING GEOMETRY AND VELOCITY SPACES. Coppi, B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3980. Advan. Plasma Phys.; 4: 173-218(1971).

The following sections are included: (1) two-dimensional initial state, (2) mode classification, (3) linearized Vlasov equation for lf modes, (4) fast modes, (5) resonant electron ballooning modes, (6) particle–wave resonances, (7) quasi-fluid electron drift mode, (8) resonant electron flute mode, (9) quasi-fluid electron flute mode, (10) slow modes, (11) slow flute modes driven by local magnetic curvature, (12) low-density ion flute mode, (13) slow fluid-like drift modes, (14) curvature-driven trapped-particle modes, and (15) impurity-particle modes. 42 references. (M.O.W.)

5554 MODIFIED BORN BACKSCATTERING FROM TURBULENT PLASMAS: ATTENUATION LEADING TO SATURATION AND CROSS-POLARIZATION. Shkarofsky, I. P. (Radio Corp. of America Ltd., Montreal). Radio Sci.; 6: No. 8-9, 819-31 (Aug-Sep 1971).

An expansion scheme, which converges rapidly, is developed for computing the backscattered cross section of electromagnetic waves from turbulent media. The scheme is based on the average rather than actual field with the use of the distorted-wave Born approximation, in which the signal is modified to include attenuation due to scattering along its path length. If the receiver beamwidth is wide enough and the scattering is very directional, no net attenuation occurs. Net loss occurs when the receiver aperture is small and the scattering is diffusive. First-order modified Born is derived in detail, and relations are evaluated. It has the potential for providing saturation in the backscattered power as the level in refractive-index fluctuation is increased. Higher-order corrections are then calculated. Second-order modified Born provides a contribution to the transverse cross-polarization that is consistent with a modified version of the result in work by R. S. Ruffine and D. A. deWolf. Both of these in turn are consistent, within the limits of directional scatter, with J. W. Strohbehn and S. F. Clifford's cross polarization, which results from fluctuations in refractive index gradients. It is also shown that the longitudinal cross-polarized component is related to diffusion effects and angle-of-arrival deviations. However, in several experiments, the postulated attenuation implicit in first-order modified Born was found to be compensated for by other effects, probably by higher-order terms. (auth)

5555 STRONG ELECTROMAGNETIC WAVES IN OVERDENSE PLASMAS. Max, Claire; Perkins, Francis (Princeton Univ., N. J.). Phys. Rev. Lett.; 27: No. 20, 1342-5(15 Nov 1971).

Two new results concerning the propagation of electromagnetic waves with a strength parameter $\nu = eE/m\omega c$ sufficiently large ($\nu \gg 1$) to cause relativistic electron velocities are reported. The first is an analytic solution of the nonlinear equations for linearly polarized waves in a uniform medium. The second is that propagation in a nonuniform medium increases the nonlinear penetration effect; the maximum nonrelativistic plasma frequency ω_p which allows transmission of a strong wave is $\omega_p^2 \approx (\omega L/c)^{\frac{4}{3}} eE_1\omega/mc$, where L is the density-gradient scale length and E_1 the electric field in the absence of a plasma. (auth)

5556 NONLINEAR LANDAU DAMPING OF ALFVEN WAVES. Hollweg, Joseph V. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 27: No. 20, 1349-52(15 Nov 1971).

It is shown that large-amplitude linearly or elliptically polarized Alfvén waves propagating parallel to $\vec{B}_0$ can be dissipated by nonlinear Landau damping. The damping is due to the longitudinal electric field associated with the ion sound wave which is driven (in second order) by the Alfvén wave. The damping rate can be large even in a cold plasma ($\beta \ll 1$, but not zero), and the mechanism which is proposed may be the dominant one in many plasmas of astrophysical interest. (auth)

5557 DOMINANT EFFECTS OF COULOMB COLLISIONS ON MAINTENANCE OF LANDAU DAMPING. Johnston, George L. (Sonoma State Coll., Rohnert Park, Calif.). Phys. Fluids; 14: No. 12, 2719-26(Dec 1971).

An analytical criterion for the maintenance, by Coulomb collisions, of the damping of a weakly damped electron wave at the rate given by the theory of Landau when nonlinear effects are present is obtained. For sufficiently small values of v, the collision frequency, the dominant collisional effects are effects of lowest order in $(v/ka)^{\frac{1}{3}}$ on the linearized distribution function perturbation. The characteristics solution for the resonant component of the linearized distribution function perturbation differs from the collisionless result only in that the factor $\mathrm{Re}\{[-i(kv-\omega)]^{-1}\}$ is replaced by an integral in which collisional effects are embodied in the parameter $\kappa = \{[v/(ka)]^{\frac{1}{3}}/[\mathrm{Im}(-\omega)/ka]\}$. Neglect of the deviation of the damping of the wave from its initial value permits determination of the spatial average distribution function perturbation in the range of time $\{[\mathrm{Im}(-\omega)]^{-1}\} \ll t \ll v^{-1}$. The principal contribution involves the resonant component of the linearized distribution function perturbation. The relative change in the slope of the spatial average distribution at $v = [\mathrm{Re}(\omega)/k]$ is determined by inspec-

tion of the integral containing κ, as well as by approximation of this integral by the method of steepest descents, to be negligible for $\kappa \gtrsim 0(1)$. For this range of κ, therefore, Coulomb collisions can maintain the damping at the rate given by the theory of Landau. The physical mechanism for this effect is the inhibition by Coulomb collisions of the resonant wave–particle interaction through which nonlinear modification of the spatial average distribution function occurs. (auth)

5558 NONLINEAR SURFACE WAVES ON AN AXISYMMETRIC MAGNETOHYDRODYNAMIC PINCH. Shen, M. C. (Univ. of Wisconsin, Madison). Phys. Fluids; 14: No. 12, 2727-32(Dec 1971).

An asymptotic approach based upon Lundquist equations is developed for the study of nonlinear wave propagation on a pinched cylindrical plasma. Wave speed and asymptotic evolution equations are derived. A comparison between linear stability criteria and results of the nonlinear theory is made, and a set of refined stability criteria is obtained. (auth)

5559 PARALLEL PROPAGATION OF NONLINEAR LOW-FREQUENCY WAVES IN HIGH-β PLASMA. Rogister, Andre (European Space Research Inst., Frascati, Italy). Phys. Fluids; 14: No. 12, 2733-9(Dec 1971).

A pair of coupled, nonlinear, partial differential equations that describe the evolution of low-frequency, large-scale-length perturbations propagating parallel, or nearly parallel, to the equilibrium magnetic field in high-β plasma were obtained. The equations account for irreversible resonant particle effects. In the regime of small but finite propagation angles, the pair of equations collapses into a single Korteweg–de Vries equation (neglecting irreversible terms) which agrees with known results. (auth)

5560 COLLECTIVE OSCILLATIONS OF A RELATIVISTIC RADIATING ELECTRON PLASMA. Hakim, Remi (Faculte des Sciences, Montpellier, France); Mangeney, Andre. Phys. Fluids; 14: No. 12, 2751-61(Dec 1971).

Results obtained previously are applied to the study of the dispersion relations of a relativistic radiating electron gas. The cases of (a) supraluminous and (b) suprathermal waves are dealt with. It is found that the effect of radiation is a negligibly small damping except for longitudinal supraluminous modes which are strongly damped. The stream instability is also studied, and it is shown that the more relativistic a beam is, the more unstable it is. (auth)

5561 STRUCTURE OF THE SECOND-ORDER PLASMA WAVE ECHO. Goforth, R.; Gentle, K. W. (Univ. of Texas, Austin). Phys. Fluids; 14: No. 12, 2778-80(Dec 1971).

Second-order electron plasma wave echoes were experimentally studied in a two-density plasma. The phase velocity of the echo rise is that of the first primary wave, and the echo decay is characteristic of the resonant plasma response at the echo frequency. (auth)

5562 SPACE-CHARGE CONDITION AND MACH NUMBER IN AN ELECTROSTATIC SHOCK. Persson, Hans (Royal Inst. of Tech., Stockholm). Phys. Fluids; 14: No. 12, 2785-6 (Dec 1971).

Electrostatic, shock-like Bernstein–Greene–Kruskal equilibria studied by Montgomery and Joyce are considered. If the electron distribution is continuous at the boundary between free and trapped electrons, the Mach number with respect to the ion sound velocity cannot be lower than unity. (auth)

5563 INSTABILITIES AND COLLECTIVE ENERGY DISSIPATION IN PLASMA SHOCK WAVES. Keilhacker, M.; Steuer, K.-H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Naturwissenschaften; 58: No. 8, 377-83(Aug 1971). (In German).

Plasma shock waves are studied in which the dissipation of energy is accomplished by collective plasma interaction rather than binary particle collisions. The collisionless dissipation is shown to be due to microinstabilities which, in low-Mach-number shocks, cause an anomalously high plasma resistivity accompanied by strong electron heating, and in high-Mach-number shocks, a collisionless viscosity resulting in ion heating. (auth)

5564 SPACE-CHARGE WAVES IN BOUNDED ANISOTROPIC PLASMAS. Poularikas, A. D.; Gong, C. (Univ. of Rhode Island, Kingston). J. Appl. Phys.; 42: No. 13, 5849-50(Dec 1971).

The dispersion relations of space charge waves in bounded inhomogeneous anisotropic plasmas were investigated previously. Here, some new findings are reported when both the electron density and the applied magnetic field are inhomogeneous. (M.O.W.)

5565 PARAMETRIC EXCITATION OF OSCILLATIONS IN THE HYBRID RESONANCE REGION. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo). Nucl. Fusion; 11: No. 5, 457-60(Oct 1971).

The excitation of longitudinal oscillations by an external hf field is investigated in a nonhomogeneous magnetoactive plasma. It is shown that, when the frequency of the subharmonic of the external hf field approaches one of the plasma hybrid frequencies, the plasma develops a parametric-type resonance. (auth)

5566 COMPREHENSIVE THEORY OF RADIOFREQUENCY ABSORPTION BY A MAGNETIZED, HOT ELECTRON-ION PLASMA COLUMN. Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). Nucl. Fusion; 11: No. 5, 556-9(Oct 1971).

A general study was made of the rf power absorbed by a plasma column when it is submitted to arbitrary TE and TM waves ($k_{||} \neq 0$). This absorbed rf power is computed in a very broad frequency domain extending from $\omega \ll \omega_{ci}$ to $\omega > \omega_{ce}$ ($\omega_{c\alpha}/2\pi$ = cyclotron frequency) for different values of the various plasma parameters. (M.O.W.)

5567 MAGNETOHYDRODYNAMIC WAVE KINETICS. II. Aleksin, V. F.; Khodusov, V. D. (Physical-Technical Inst., Kharkov. Donetsk Physical-Technical Inst., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 603-8(Apr 1971). (In Russian).

By means of the magnetohydrodynamic-wave interaction Hamiltonian previously constructed, concrete decay processes of these waves were considered in plasma of low gas-kinetic pressure ($V_S/V_A \gg 1$) Average relaxation times of the wave spectra and increments of low-intensity waves were calculated in their interaction with the intensive Alfvén wave and fast magnetosonic one. (auth)

5568 EXPERIMENTAL OBSERVATION OF WAVE–WAVE COUPLING IN A BEAM–PLASMA SYSTEM. Chang, J.; Raether, M.; Tanaka, S. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 27: No. 19, 1263-6(8 Nov 1971).

The interaction between unstable waves was investigated in a beam–plasma system under conditions such that nonlinear wave–particle interactions are negligible. At small wave amplitudes the results can be interpreted in terms of a simple three-wave decay process; at large amplitudes the situation is dominated by multiple wave coupling that leads to generation of satellite waves. (auth)

5569 NONLOCAL INSTABILITY OF FINITE-AMPLITUDE ION WAVES. Stern, R. A.; Decker, J. F. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett.; 27: No. 19, 1266-70(8 Nov 1971).

Instability of electrostatic ion shock waves was induced by producing an inhomogeneity in the plasma ahead of the wave. A process based on nonlocal instability of precursor ions ejected ahead of finite-amplitude waves is proposed. In addition, instabilities of large-amplitude ion-acoustic waves were observed and are ascribed to a similar process. (auth)

5570 NONLINEAR EXCITATION OF WAVES IN A PLASMA BY HIGH POWER MICROWAVES. Shiue, James Chen Chi. New York; New York Univ. (1971). 245p. University Microfilms Order No. 71-23,053.

Thesis.

Nonlinear excitation of electron plasma and ion acoustic waves in a plasma was investigated theoretically and experimentally. Threshold conditions for instability from a parametric theory based on a fluid description of a homogeneous, isotropic unbounded electron–ion plasma are developed, taking into account the vector character of both pumping and driven waves. The results display the directional characteristics of thresholds. For a longitudinal pumping wave, the threshold reaches an absolute minimum when the driven waves are backward traveling plasmons with respect to the pump wave. The finite size of the laboratory plasma is taken into consideration by means of a parallel-plane slab model. A transmission-line-equivalent circuit is used to represent the plasma slab, from which the coupling between an E-polarized incident electromagnetic wave and longitudinal electron plasma wave inside the plasma is determined. The enhancement of the internal longitudinal electric field when the slab is at resonance to the incident microwave is ascertained from the equivalent circuit. Experimental thresholds are in agreement with theoretical values with realistic dampings for ion acoustic and electron plasma waves when the resonance enhancement of the longitudinal pumping field is taken into consideration. The dependence of the threshold on background plasma parameters is in qualitative agreement with the theory. Waveguide experiments were conducted in argon and mercury plasma columns. The frequency dependence of the observed low-frequency waves on ion mass, electron temperature, and plasma column diameter are in agreement with the model of a radial ion acoustic wave. Responses of the

plasma column to microwave pulses reveal that parametric excitation of ion acoustic waves is preceded by the suppression of striations, while probe measurements show only an insignificant rise in electron temperature due to the strong microwave power level. (Diss. Abstr. Int., B)

5571 ECHO EFFECT IN RELATIVISTIC PLASMA. Pavlenko, V. N.; Tomchuk, P. M. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 788-93(May 1971). (In Russian).

Effects of time echoes are considered in relativistic electron plasmas. It is shown that, at a repeated excitation in such a plasma with strong damping oscillations, there may arise slightly damped long-wave echo oscillations. The presence of the electron limiting velocity, taking into account relativistic effects, essentially affects the form of the echo oscillations. (auth)

5572 DISPERSION CHARACTERISTICS OF SLOW WAVES IN A PLASMA LAYER. Grechko, L. G.; Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 682-5(Apr 1971). (In Russian).

One of the characteristic features of a plasma is its dielectric penetrability, which may assume negative values. This fact is responsible for slow surface waves at the vacuum/plasma boundary. The dispersion equations are analyzed for slow surface waves in the plasma layer, and the excitation of these waves by an external electron current is examined. (K.S.W.)

Radiation Physics and Shielding

Radiation Physics

Refer also to abstracts 5005, 5154, 5183, 5602, 5760, and 5945.

5573 (CEA-R-4198) EVALUATION OF STOPPING POWER AND RANGE OF CHARGED PARTICLES OF 10 MeV TO 30 GeV IN MATTER. Bertel, Evelyne; Pages, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 129p. (In French). Dep. NTIS (U. S. Sales Only).

A code written in FORTRAN IV for IBM 360/91 of Saclay's D.C.E. gives an evaluation of the dE/dx and range of charged particles of 10 MeV to 30 GeV in matter. The BETHE–BLOCH formula is used, corrected for taking account of the density effect (STERNHEIMER) and shell correction (BARKAS). Results are given for some simple elements and compounds. (auth)

5574 (FRNC-TH-78) STUDY OF THE AFTERGLOW OF ALPHA-IRRADIATED NITROGEN–OXYGEN MIXTURES. Salamero, Yves (Toulouse Univ. (France)). 1971. 83p. (In French). Dep. NTIS (U. S. Sales Only).

The emission spectrum of nitrogen at pressures of several hundred torr excited by α particles of 5.3 MeV, includes: $C^3\pi_u B^3\pi_g$ transitions of the N_2 system; $B^2\Sigma_u^+ X^2\Sigma_g^+$ transitions of the N_2^+ system; and a group of bands attributed to the NO gamma system. In all cases, when oxygen is added in varying quantities, the total intensity of the emission spectrum decreases. The study of the variation of the decay time constant as a function of the partial pressure of nitrogen p_N for a given value of the oxygen partial pressure p_O allows information to be obtained about the deexcitation processes. (France)

5575 (N-71-28127) ELECTRON AND BREMSSTRAHLUNG PENETRATION AND DOSE CALCULATION. Watts, John W. Jr.; Burrell, M. O. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jun 1971. 95p. (NASA-TN-D-6385). NTIS.

Various techniques for calculation of electron and bremsstrahlung dose deposition are described. New energy deposition, transmission, and reflection coefficients for electrons incident on plane slabs for angles of 0, 30, 60, 75, and 89.9° and energies of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, and 10.0 MeV are presented, and methods for their use in electron dose calculations are developed. A method for electron dose calculations by approximation is also developed and the various methods are compared and found to be in good agreement. Accurate and approximate methods of calculating bremsstrahlung dose are also derived and compared. (auth) (STAR)

5576 (NP-19085) RESONANCE PHENOMENA DURING MULTIPHOTON IONIZATION OF XENON ATOMS IN ELECTRIC FIELDS OF $E \sim 5 \times 10^7$ V/cm. Alimov, D. T.; Berezhetskaya, N. K.; Delone, G. A.; Delone, N. B. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A study was conducted of the eleventh ionization process for a xenon atom by means of a Nd glass laser. The amplitude of the ion signal was determined as a function of the energy of the laser radiation, and the changes in ion yield were measured. The experimental results show that for a field intensity of 5×10^7 volts/cm, the resonance effects play an essential role, whereas effects associated with a virtual transition through strongly excited levels are not manifest. (K.S.W.)

5577 (ORNL-tr-2534) METHOD FOR THE DETERMINATION OF DIFFERENTIAL ALBEDOS FOR 1 TO 17-MeV PHOTONS. Vogt, Hans-Gerrit (Technische Universitaet, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from a German report. 82p. Dep. NTIS.

Thesis.

A measuring method is described that permits the determination of differential albedos for photons in the energy region of an electron accelerator. The experimental configuration makes use of a narrow beam incident on the test material, which can be rotated and pivoted. A NaI crystal scintillator serves as the detector which can be moved around the scatterer on a circular rail. Each single measurement of the radiation intensity backscattered by the test material and the intensity incident on the material first allows a derivation of effective albedo values for the bremsstrahlung utilized in each angular position. This leads to albedo values for monoenergetic radiation by applying an unfolding method to the bremsstrahlung spectra of different maximum energies. The performance of the highly voluminous calculations was made possible only with a supportable consumption of analysis time by the development of several computer programs that perform an automatic calculation of the albedo values from experimental data. The method was tested with aluminum as the scattering material. The direction-dependent dose albedo, as well as the direction- and energy-dependent number albedo, were investigated in the energy region 2 to 17 MeV that had not yet been determined experimentally. The albedo values found refer to the particle current density. In part, they could be compared with the results of Monte Carlo calculations. Such calculations are available for ordinary concrete, which exhibits a similar attenuation and scattering behavior as aluminum. At low energies the experiment and calculation showed satisfactory agreement. The deviations at higher energies might be attributable to an inaccurate consideration of the pair production effect in the calculations. In a further comparison with the results of an empirical formula, some notable deviations were found. Since the parameters of this formula are obtained from Monte Carlo calculations with relatively small statistical accuracy, only a limited reliability of this formula can be expected. (M.H.R.)

5578 (ORO-3027-20) EXPERIMENTAL INVESTIGATION OF THE CHARACTERISTIC ENERGY LOSSES OF 3 TO 10 keV LITHIUM PARTICLES IN THIN FILMS. Technical Summary Report. Majure, J. C.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). 31 Aug 1971. Contract AT(40-1)-3027. 179p. Dep. NTIS.

An experimental facility and associated techniques were developed for the study of the characteristic energy losses experienced by heavy particles upon passage through thin solid films. The facility and techniques allow the energy losses and particle fluxes to be determined as a function of emergence angle and incident energy. The techniques were used to determine the energy distributions of lithium particles transmitted through thin carbon films at angles between 0 and 60 degrees at input energies of 10, 8, 6, and 4 keV. The angular dependence of the flux of all transmitted lithium particles was also determined for incident energies of 10, 8, 6, and 4 keV. From the energy distributions, the most probable and average energy losses were determined as a function of angle and input energy. The average energy loss of all emerging particles was then determined for each input energy. The increment of projected range (film thickness) through which the particles had passed was determined interferometrically. By using the bulk density of carbon and another "fitted" density, experimental stopping cross sections and particle flux were compared to existing theories. The experimental stopping cross section indicates that Lindhard's nuclear stopping cross section based on a fit of an r^{-2} potential to the Thomas–Fermi potential is more accurate in the 3- to 10-keV range than the cross section determined from the Thomas–Fermi potential directly. The multiple scattering theory of Meyer (Phys. Status Solidi B, 44: 253(1971)) was found to agree with the experimental angular flux determinations for 8-keV input energy. For the energy region investigated in this research, it is clear that the most probable energy loss at zero degrees is caused not only by the more dominant electronic stopping, but by nuclear stopping as well. (auth)

5579 (RT/PROT-(70)39) FLUCTUATIONS OF ENERGY LOSSES OF LOW-ENERGY ALPHA PARTICLES IN A THIN LAYER. Frittelli, L. (Comitato Nazionale per l'Energia Nu-

cleare, Rome (Italy)). 4 Jan 1971. 36p. (In Italian). Dep. NTIS (U. S. Sales Only).

The straggling distributions of low-energy alpha particles in thin absorbers are revised. (auth)

5580 (SC-RR-710599) SPATIAL DISTRIBUTION OF IONS INCIDENT ON A SOLID TARGET AS A FUNCTION OF INSTANTANEOUS ENERGY. Brice, David K. (Sandia Labs., Albuquerque, N. Mex.). Sep 1971. 252p. Dep. NTIS.

Integro-differential equations are derived which govern the spatial distribution of ions of energy E′ moving in a solid target after the ions were incident on the target surface with energy E. These equations are specialized to integral equations which govern the first and second spatial moments of the distribution. Solutions to the moments equations are obtained to second order for an expansion of the integrands in powers of T, the energy transfer in a single collision between an ion and an atom (or electron) of the target. These solutions allow construction of the spatial distribution function in the gaussian approximation. Similar equations are also derived and solved for the average range along path of the ions at energy E′. (auth)

5581 ENERGY SPREAD IN THIN ABSORBERS. Clarke, N. M. (King's Coll., London). Nucl. Instrum. Methods; 96: No. 4, 497-503(1971).

The energy spread introduced into a mono-energetic beam passing through a thin absorber is calculated for a range of incident particles ($\pi^{\pm}$, $K^{\pm}$, p, d, t, ^{3}He, ^{4}He, and heavy ions generally). An absorber thickness equivalent to 0.5% of the incident energy is chosen and results are presented graphically for absorbers of C, Al, Fe, Sn and Pb. (auth)

5582 ENERGY LOSS STRAGGLING OF PROTONS IN NICKEL. Penkrot, J. A.; Cohen, B. L.; Rao, G. R.; Fulmer, R. H. (Univ. of Pittsburgh). Nucl. Instrum. Methods; 96: No. 4, 505-8(1971).

The distribution of energy losses of 17 MeV protons in passing through nickel foils of various thickness (t) was measured. The widths of the distributions at $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{10}$ maximum agree well with the theoretical predictions. For small t, the widths vary linearly with t as predicted by the theory rather than with $t^{\frac{1}{2}}$ as might be naively expected. The skewness of the distributions is also in agreement with the theory. (auth)

5583 BOUNDS TO TRUNCATION ERRORS IN BIORTHOGONAL POLYNOMIAL APPROXIMATIONS, WITH ILLUSTRATIVE APPLICATIONS TO GAMMA-RAY TRANSPORT DISTRIBUTIONS. Spencer, L. V. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 75B: No. 1-2, 1-16(Jan-Jun 1971).

Problems of gamma-ray and neutron penetration in infinite, homogeneous media can be solved in terms of infinite sums of a certain type of biorthogonal polynomial system. Many calculations have used a few terms, perhaps 4 to 8, successfully due to good apparent convergence. This paper develops expressions for terms, perhaps 4 to 8, successfully due to good apparent convergence. This paper develops expressions for bounds to the truncation error of these finite sums. Examples and applications are given of the functions used to obtain the error bounds. (auth)

5584 ELECTRON FLUX SPECTRA AND RADIATION YIELDS IN SOLIDS IRRADIATED BY BETA RAYS. Birkhoff, R. D. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 233-41(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

During the last few years a program has been under way at Oak Ridge National Laboratory to measure the electron flux in an irradiated medium. A typical source consists of several curies of beta radioactivity uniformly dispersed in a metal, the whole approximating a homogeneous, uniformly and isotropically irradiated medium. The electron flux escaping from a cavity within the medium is measured over the energy range from about 50 keV down to 1 eV. At the higher energies the flux observed is due entirely to the beta rays from the source whereas, below 10 keV, the flux rises by as many as five orders of magnitude, this rise being due to the generation of secondary, tertiary, quarternary, and higher generations of electrons. The measurements are in approximate agreement with the Spencer–Fano theory of electron slowing down above ten keV, but tend to indicate that the theory underestimates the flux below this energy by as much as a factor of four. Theoretical ionization and plasmon cross sections for aluminum have been combined with our flux data to calculate the probability of occurrence of a given type of event from a beta ray from a copper-64 or gold-198 source. Calculations show that most K-ionizations (~3) are caused by the primary beta ray, whereas L-shell ionizations and plasmon excitations tend to come from the secondary electrons (~300 for the former and ~20,000 for the latter). Since each plasmon requires 15 eV in the aluminum medium for which the calculations were made, it seems that essentially all of the original beta-ray energy ultimately appears as plasmon excitation. (auth)

5585 PREDICTED AND MEASURED DEPTH DOSE PROFILES FOR PULSED ELECTRON SPECTRA. Schallhorn, D. R.; Buxton, L. D. (Harry Diamond Labs., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 242-9(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Experimentally measured depth dose profiles for several materials are compared with theoretical profiles calculated by the electron transport computer code ZEBRA. The experimental profiles were obtained using a unique technique. The materials were exposed to the pulsed electron beam from the flash x-ray at HDL and the materials' rear surface motion induced by the exposure was measured with a laser interferometer. These measured responses were then converted to velocity histories, which can be related to the depth-dose profiles. The depth-dose profiles of nine materials with atomic numbers ranging from 13 to 79 were measured. For three of these materials, profiles were obtained for more than one electron spectrum. In general, the measured and calculated profiles agree with each other well enough to demonstrate the applicability of this experimental technique to a wide range of materials and electron spectra. (auth)

5586 HIGH INTENSITY PULSED ELECTRON BEAM ENERGY DEPOSITION IN SOLID DIELECTRICS. Little, R.; Ottesen, J.; Childers, F. K. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 250-4(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Results of two experiments performed in order to gain an understanding of the interaction or primary electrons with solid Lucite, which is representative of very-high-resistivity dielectrics, are presented. The first experiment consisted of measuring energy-deposition profiles in the solid dielectric using calorimetric techniques. These measured profiles were compared to Monte Carlo electron transport code calculations. The data showed that, while the shapes of the profiles were not strongly different than an equivalent-thickness conducting material, an integration of the profiles resulted in anomalously high beam energy fluences. This latter effect was then investigated by measuring electron beam energy fluences transmitted through equivalent thicknesses of conducting and dielectric absorbers. These data, also presented here, show that the presence of a solid dielectric has an effect upon the electron beam spatial distribution for the conditions studied. For all the experiments, pulsed high-intensity 2.0-MeV electron beams were used for energy deposition. (auth)

5587 PENETRATION ABILITIES OF LOW-ENERGY ELECTRONS AND POSITRONS IN LEAD AND ALUMINUM. Vertman, E. G.; Vorob'ev, S. A.; Timoshnikov, Yu. A.; Tsekhanovskii, I. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 135-7(1971). (In Russian).

The penetrating power of electrons and positrons in Pb and Al was studied. The isotopes ^{137}Cs and ^{22}Na were used as sources of β particles, and a magnetic beta spectrometer provided an energy resolution of 3.0%. Absorption curves for electrons and positrons in the two absorbers were drawn, and the relative behavior of the two particles is discussed. (K.S.W.)

5588 EFFECT OF THE GROUND ON THE STEADY-STATE AND TIME-DEPENDENT TRANSPORT OF NEUTRONS AND SECONDARY GAMMA RAYS IN THE ATMOSPHERE. Straker, E. A. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 46: No. 3, 334-55(Dec 1971).

Calculations were made of the space, energy, angle, and time dependence of the neutron and secondary gamma-ray fields produced in the atmosphere by several neutron sources, and the results for a 12.2- to 15-MeV source and a fission source are compared. They include steady-state and time-dependent results at ranges out to 1500 m for both an infinite air medium and an air-over-ground medium, the latter for source heights of 15 and 343 m. The data show that the neutron doses and dose rates from the 12.2- to 15-MeV source are higher than those from the fission source in all geometries and time intervals. While the secondary gamma-ray doses produced by the 12.2- to 15-MeV source also are higher than those produced by the fission source in all geometries, the secondary dose rates are higher only for times less than 10^{-3} sec, after which the dose rates from the two sources are comparable. The effects of the

ground are to enhance both the neutrons and the secondary gamma rays at ranges close to the source and to act as an absorber at ranges far from the source. These effects decrease with increasing source height. (auth)

5589 DETERMINATION OF KILOVOLT ELECTRON ENERGY DISSIPATION VS PENETRATION DISTANCE IN SOLID MATERIALS. Everhart, T. E.; Hoff, P. H. (Univ. of California, Berkeley). J. Appl. Phys.; 42: No. 13, 5837-46(Dec 1971).

A universal curve of energy-dissipation range vs normalized electron energy is proposed, which includes the average atomic number Z of the material being bombarded in the energy normalization factor. Range–energy expressions of the form $R = kE_B^{\alpha}$, derived from the Bohr–Bethe energy-loss relation, are valid over limited energy ranges, but the exponent α differs for materials of greatly different atomic numbers over the same energy range. For the aluminum/silicon dioxide/silicon system used here, $R_C = 4.0\ E_B(keV)^{1.75} \mu g/cm^2$ was found accurate for $5 < E_B < 25$ keV. Using this value of range, and taking the steady-state electron-beam-induced current through a thin insulating layer of SiO_2 as a measure of the energy dissipation in that layer, an energy-dissipation (depth-dose) function was determined that should be valid for $10 < Z < 15$. Using this normalized expression $\lambda(y) = 0.60 + 6.21y - 12.40y^2 + 5.69y^3$ and the range R_C, the energy dissipated at any depth may be determined, and hence the carrier-pair generation in semiconductors, light generation in phosphors, etc., may be predicted. An expression relating the depth-dose function to the applied voltage drop across the oxide provided an independent check on the experimental measurements and the assumptions used in reducing the data. The ratio of (mobility × lifetime) to the (mean electron excitation energy in the oxide) was found to be $(\mu\tau/E_A) = (2.97 \pm 0.06) \times 10^{-13} (cm/V)^2$ using the energy-dissipation formulation, and $(\mu\tau/E_A) = (3.00 \pm 0.05) \times 10^{-13} (cm/V)^2$ using the energy-dissipation formulation, and $(\mu\tau/E_A) = (3.00 \pm 0.05) \times 10^{-13} (cm/V)^2$ using the check expression, where the errors quoted are root-mean-square deviations computed for 12 or more points. (auth)

5590 EMPIRICAL EQUATIONS FOR THE PROJECTED-RANGE STRAGGLING OF 4- TO 24-MeV ELECTRONS. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru; Fujita, Yoshiaki. (Kyoto Univ.). Annu. Rep. Radiat. Center Osaka Prefect.; 11: 67-70 (1970).

An empirical equation for the projected-range-straggling (PRS) distribution of 4- to 24-MeV electrons has been developed by utilizing the expression of Ebert et al. for the transmission curve in a modified form. The curves given by the equation are compared with the charge-deposition distributions observed and those calculated with the Monte Carlo method by Berger and Seltzer, because these distributions can be considered to represent the PRS distributions to a good approximation. The comparison shows that the empirical equation reproduces the actual PRS distribution well, except for slight discrepancies in the cases of low-Z absorbers. Empirical relations for the PRS parameter ΔR are also described. (auth)

5591 SEMI-EMPIRICAL EQUATION FOR THE MEAN PROJECTED RANGE OF ELECTRONS. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 71-4(1970).

The semi-empirical equation between the mean projected range R and the mean range L of electrons developed by one of the present authors was modified. The new relation is of the form $R = L(1 + L/\lambda')^{-1}$, where $\lambda^0 = \lambda_0/f(Z, \epsilon_0)$; λ_0 is the transport mean free path of the incident electrons, and ϵ_0 is the incident kinetic energy of the electrons in units of the rest energy of the electron. Assuming a linear function of ϵ_0 for $f(Z,\epsilon_0)$, satisfactory agreement with experimental and Monte Carlo results was obtained for energies from 2 to 24 MeV. However, another modification previously reported shows a better agreement with the Monte Carlo results down to 0.25 MeV. Equations that express the mean range as a function of energy in the region from 10 keV to 1 GeV are given. (auth)

5592 FUNDAMENTAL DATA ON RADIATION PHYSICS. 1. Sugiyama, Haruo (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku; No. 170, 1-122(Dec 1970). (In Japanese).

An attempt to propose a handy data book concerning interaction of radiation with matter for scientists and engineers engaged in radiation dosimetry or related fields is presented. Radiation quantities and units, photon attenuation coefficients, electron stopping power and range, proton stopping power and range, energy spectra of bremsstrahlung photons, backscattering of electrons and photons, slowing down spectra of electrons, electron energy dissipation curves, and W values are presented. (auth) (Japan)

Shielding

Refer also to abstract 5943.

5593 (AD–703124) ANALYSIS OF ROOF RADIATION EXPERIMENTS UNDER TYPICAL AND IDEAL CONDITIONS. Final Report. Spring, Robert; Velletri, Joseph (CGS Scientific Corp., Watertown, Mass. Datametrics Div.). Nov 1969. Contract DAHC20-70-C-0227. 58p. (CGS-TR-29). NTIS.

Three sets of experiments performed at the Radiation Test Facility are described. The first series was concerned with measuring the exposure rate within a cylindrical interior partition below an annular plane of radiation on a four-inch-thick concrete roof. The second series was similar to the first but was performed on the rectangular test structure at the RTF. The final experiment reported measured the exposure rate from a twelve-foot-disk source attenuated by a two-inch (25 psf) concrete slab. Agreement of theory with the experimental results is excellent. (USGRDR)

5594 (AD-709648) EXPERIMENTAL STUDY OF THE "IN-AND-DOWN" COMPONENT OF RADIATION FROM GROUND BASED SOURCES. Final Report. Spring, Robert L.; Velletri, Joseph (CGS Scientific Corp., Watertown, Mass. Datametrics Div.). Jun 1970. Contract DAHC20-70-C-0027. 57p. (CGS-TR-31). NTIS.

Results of an experimental program designed to measure the attenuating properties of a four-inch-thick basement ceiling against gamma rays scattered in the above-ground wall are analyzed. A six-foot-diameter concrete cylinder of varying wall height was used as the test structure. A six-foot-diameter, six-foot-deep cylinder was used as the basement directly under the superstructure. Several comparisons with various theoretical methods and other experimental programs are shown. (auth) (USGRDR)

5595 (LUNP–7008) MODEL EXPERIMENT FOR DIMENSIONING A RADIATION SHIELD. Moellerberg, Rolf (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Jul 1970. 24p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The theory and its limitations are discussed. With the simplest possible geometry, a model experiment was compared with a full-scale experiment. Because of difficulties with the Van de Graaff accelerator, misleading figures were obtained in the full-scale experiment. In the model experiment a coaxial detector was used, and the response matrix was calculated for a distant point source. This matrix gives certain errors when applied to radiation coming from a large area near the detector. Error estimations were not done. (Sweden)

5596 CALCULATION OF THE BLOCK SYSTEM BY THE DOSE RATE FOR HIGH-RATE ISOTOPIC γ-INSTALLATIONS WITH A LABYRINTH- AND LABYRINTH-LESS SHIELDING. Videnskaya, M. M.; Kurovich, V. N.; Shirokovskikh, G. I. Izotopy SSSR; No. 19, 8-11(1970). (In Russian).

A method is proposed for calculating blocking systems according to the size of the gamma dose with and without labyrinth shielding. Blocking systems were tested in five operating installations and found to be satisfactory for high-level gamma facilities of every construction and for a wide range of gamma radiation levels. (tr-INIS)

5597 SIMPLIFIED CALCULATIONS FOR RADIATION SHIELDING. Moulthrop, Homer A. (Atlantic Richfield Hanford Co., Richland, Wash.). Power Eng.; 75: No. 11, 42-3 (Nov 1971).

Charts are discussed that relate: volume and activity content to dose rate and dose rates to needed shielding thicknesses. Dose rates for ten of the more frequently occurring radionuclides in aqueous solution were calculated for a range of cylindrical tank sizes. The charts relate each shielding material (iron, lead, and concrete) to the calculated dose rate for each of the ten radionuclides. Each chart employs a separate curve for each of the twelve volumes. (M.H.R.)

Solid-State Physics

Refer also to abstract 5352.

5598 (CONF-701219–(Vol.3)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, MADURAI, DECEMBER 27–30, 1970. VOLUME III. SOLID STATE PHYSICS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1970. 788p.

A total of 146 papers are presented, grouped under the headings: Low-Temperature Behavior of Solids and Liquids, Electronic Properties of Solids, Thermal and Dynamical Properties of Solids

and Liquids, and Magnetic Properties of Solids. Separate abstracts were prepared for twelve of the papers. (D.L.C.)

For abstracts of individual papers see: 5363, 5364, 5400, 5402, 5403, 5511, 5623–5625, and 5674–5676.

Radiation Effects

Refer also to abstracts 4622, 4648, 4655, 5154, 5580, and 5917.

5599 (CEA-Bib-196) RADIATION EFFECTS ON IONIC CRYSTALS. Lobier, Gerard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1971. 48p. (In French). Dep. NTIS (U. S. Sales Only).

The effects of radiation on ionic crystals are reviewed, with particular emphasis on alkali halides with fcc structures. The following topics are presented: the effects of radiation on optical, mechanical, and transport properties, the study of basic mechanisms postulated to explain point defect formation, and experiments on rare gas diffusion in ionic crystals exposed to neutrons. (74 references) (auth) (France)

5600 (ORO-3912-10) COMPUTER SIMULATION OF RADIATION-INDUCED VOID NUCLEATION AND GROWTH IN METALS. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). Jun 1971. Contract AT(40-1)-3912. 58p. (CONF-710601-16). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

Computer simulation of crystal lattice defects production by atomic collision cascades and by isolated collision events has been used to generate primary damage states in cubic metals. Both unsaturated and saturated damage states have been generated in this manner. Thermal annealing of these damage states was also simulated. The influence of pre-existing dislocations and of grain-boundary sinks was not included in the annealing simulations. The development of embryo void nuclei turned out to be an inevitible consequence of approaching a saturated damage state, regardless of whether the defects were produced by cascades or by isolated collision events. Both homogeneous and heterogeneous nucleation of voids were observed. Long-term stability of a void against both thermal dissociation and radiation attrition required impurity atom stabilization of the edges and corners of a faceted void. This is called external stabilization. Internal stabilization by the containment of rare gas atoms was not treated explicity. Thermal decomposition of faceted voids began via an unzipping process at the corners. (auth)

5601 PARTICLE CHANNELING IN CRYSTALS WITH A COMPLICATED BASIS. Martynenko, Yu. V. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 876-7(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1055-7(Apr 1971).

A general condition is obtained for the channeling of a classical particle in a crystal that enables one to consider crystals with a complicated basis. (auth)

5602 ENERGY LOSS OF H, D, AND ^{4}He IONS CHANNELED THROUGH THIN SINGLE CRYSTALS OF SILICON. Della Mea, G. (Univ., Padua); Drigo, A. V.; Lo Russo, S.; Mazzoldi, P.; Bentini, G. G. Phys. Rev. Lett.; 27: No. 18, 1194-6(1 Nov 1971).

The energy loss of ions channeled through the ⟨111⟩ Si channel is studied in the energy range 0.9 to 5.0 MeV. The energy dependence of the ratio between channeling and random stopping power above 3 MeV shows an increase which can be interpreted in terms of core–electron excitation. The velocity dependence of the channeling stopping power is also studied. (auth)

5603 IMPURITY COLOR CENTERS IN QUARTZ AND TRAPPED ELECTRON DATING: ELECTRON SPIN RESONANCE AND THERMOLUMINESCENCE STUDIES. McMorris, Daniel W. (TRW, Inc., Redondo Beach, Calif.). J. Geophys. Res.; 76: No. 32, 7875-87(10 Nov 1971).

Natural smoky quartz exhibits ESR signals and also thermoluminescence (TL) peaks having blue emission. The effects are caused by electron/hole trapping and can be induced artificially by various radiations. The traps are filled slowly by natural background radiation and are of interest for dating. In the present work, impurity-related traps that are known to be sensitive to ionizing radiations were investigated. ESR equivalent natural doses were determined for the Al hole trap in virgin specimens; the doses agreed with estimates based on published data for the Ge electron trap. The 0.17°/sec 180° and 300°C TL peaks in natural specimens were found to have activation energies approximately correct for the Ge trap. The 300°C peak was also found to be correlated with annealing of the Ge electron resonance in γ-irradiated, step-annealed specimens. Although the 300°C peak occurs in virgin specimens, the corresponding natural Ge electron resonance was not observed. Annealing of the Ti electron resonance did not cause a blue TL emission, which indicates that the Ge-activated TL does not occur on the Al site as is often supposed. A phenomenological equation for trap filling is suggested; it includes an alkali migration and trapping mechanism, and first-order kinetics are assumed. In natural specimens, the trapped electron concentrations are found to be limited either by trap saturation or by secular equilibrium, whichever occurs first. (auth)

5604 INFRARED LOCALIZED-VIBRATIONAL-MODE ABSORPTION OF ION-IMPLANTED ALUMINUM AND PHOSPHOROUS IN GALLIUM ARSENIDE. Skolnik, L. H. (Univ. of Southern California, Los Angeles); Spitzer, W. G.; Kahan, A.; Hunsperger, R. G. J. Appl. Phys.; 42: No. 13, 5223-9(Dec 1971).

The localized-vibrational-mode absorption of ion-implanted Al and P in GaAs is observed. The implants were done at room temperature with a flux of $\sim 3 \times 10^{12}$ ion/cm^2 sec and fluences of 2.0×10^{16}, 2.8×10^{16}, and 3.7×10^{16}/cm^2 at 1 MeV. The $\Delta n = 1$ transition of Al substitutional on the Ga sublattice and P substitutional on the As sublattice are observed, and liquid-nitrogen-temperature absorption measurements are made for isochronal anneals from 200 to 900°C. The Al-implanted GaAs shows an Al_{Ga} local mode near 362 cm^{-1} and GaAs implanted with P shows a band near 355 cm^{-1} similar to melt-doped crystals, but with increased linewidths. From the integrated absorption, it is estimated that nearly all of the Al and P is Al_{Ga} and P_{As} after 900°C anneal, and the site symmetry is approximately tetrahedral. (auth)

5605 LIGHT AND CURRENT PULSES FROM X-RAYED POTASSIUM DI-HYDROGEN PHOSPHATE CRYSTALS. Zerem, J. Z.; Halperin, A. (Hebrew Univ., Jerusalem). J. Appl. Phys.; 42: No. 13, 5263-6(Dec 1971).

Short-duration light pulses accompanied by current pulses were observed on warming KDP crystals x-ray irradiated at 77°K. The pulses start a few degrees above the transition temperature (T_c = 123°K) and continue until about 200°K. The pulses appear only under ambient gas pressures above about 0.1 torr. Warming of the irradiated crystal to an intermediate temperature between T_c and 200°K causes only a partial exhaustion of the pulses, and after cooling and reheating pulses appear only above the temperature reached in the former cycle. The pulses originate from discharges into the surrounding atmosphere. A simple model is given to account for the experimental results. (auth)

5606 SURFACE CHARGING OF INSULATORS BY ION IRRADIATION. Vance, Dennis W. (Xerox Research Labs., Rochester, N. Y.). J. Appl. Phys.; 42: No. 13, 5430-43(Dec 1971).

The charging of insulating surfaces by irradiation with gaseous ions is discussed from the viewpoint of basic interactions between individual ions and surfaces. Experiments are reported in which mass-selected beams of low-energy positive and negative ions are used to irradiate insulating amorphous selenium films. The surface-charging efficiency (the number of charges retained on the surface per incident ion) is found to be initially equal to 1, independent of the ion species and ion kinetic energy. As charge accumulates on the surface, the charging efficiency decreases, the extent of decrease being a function of species and kinetic energy. The results are shown to be consistent with a model in which the ion injects a hole or an electron into the solid and the injected carrier is trapped in a surface state. The deviation of the charging efficiency from unity arises as a result of free carrier generation in the solid by means of a transfer of kinetic and/or potential energy from the neutralized ion. Implications of the selenium results to insulator charging in general are considered. (auth)

5607 ISOTHERMAL ANNEALING OF THE 0.97-eV LUMINESCENE IN ELECTRON-IRRADIATED Si. Wong, E. H.; Streetman, B. G. (Univ. of Illinois, Urbana). J. Appl. Phys.; 42: No. 13, 5882-3(Dec 1971).

Low-temperature photoluminescence in pulled Si irradiated with 3-MeV electrons exhibits a prominent zero-phonon line at 0.97 eV, which anneals between 200 and 275°C according to previous isochronal data. Isothermal annealing measurements are reported that reveal an activation energy of about 1.34 eV for the annealing of this line. (auth)

5608 ELECTRON CENTERS DESTRUCTION AND RESTORATION IN PROTON AND ALPHA-PARTICLE TRACKS IN ALKALI HALIDE CRYSTALS. Vaisburd, D. I.; Kravets, A. N.; Melikyan, L. A.; Minaev, S. M. (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: No. 6, 461-4(1970). (In Russian).

The contribution of the three most probable mechanisms for destruction of electron centers in proton and α-particle tracks

is separated, namely: annihilation with an interstitial halogen atom, excitons, and hole mechanisms. The holes are shown to prevail over the excitons and interstitials. It was found that F_2 centers, first destroyed at low temperatures, fast restore under irradiation at room temperature. The kinetics of the restoration of F_2 centers is used to determine the effective radii of proton and alpha-particle tracks in NaCl crystals. (auth)

5609 REACTOR IRRADIATION OF SELENIUM SINGLE CRYSTALS. Tiainen, O. J. A. (State Inst. for Tech. Research, Otaniemi, Finland). Phys. Lett.; 37A: No. 3, 237-8(22 Nov 1971).

Selenium single crystals were irradiated in a reactor at temperatures of about 320°K. The resistivity was found to increase linearly with increasing irradiation time, and a decrease in thermoelectric power was observed after irradiation. (auth)

5610 ACCEPTOR PROFILES IN SILICON IMPLANTED WITH BORON AT 77°K. Matthews, M. D. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett.; 37A: No. 3, 257-8(22 Nov 1971).

Interesting and unusual acceptor profiles in depth were obtained in silicon implanted with boron at 77°K which, it is thought, reflect the depth distribution of damage beneath the surface. (auth)

5611 INFLUENCE OF SURFACE SEMICHANNELS ON ION SCATTERING BY CRYSTALS. Shulga, V. I.; Bunin, I. G.; Yurasova, V. E.; Andreev, V. V.; Mamaev, B. M. (Moscow State Univ.). Phys. Lett.; 37A: No. 3, 181-3(22 Nov 1971).

Some results of experiments and a computer study of the spatial distribution of 4.5-keV Ar ions reflected from a Cu single crystal are presented. (auth)

5612 EFFECT OF POINT DEFECTS ON ANGULAR DISTRIBUTION OF ANNIHILATION PHOTONS IN SINGLE CRYSTALS OF TUNGSTEN. Adamenko, A. A.; Shalaev, A. M. (Inst. of Metallophysics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 6, 1030-2(Jun 1971). (In Russian).

The change in angular distribution of annihilation photons in monocrystals of tungsten was studied; this change resulted from point defects that arose under the action of intense γ radiation and subsequent annealing. Tungsten crystals, annealed at 2000°C, were irradiated with a Co source at 1.6×10^9 R at 50°C. The isotope ^{22}Na was the positron source; the annihilation photons were produced in the decay scheme. The angular distribution was measured before and after irradiation, and is discussed in terms of annihilated quanta and annealing of the specimens. (K.S.W.)

5613 MICROSCOPIC VIEW OF RADIATION DAMAGE IN SEMICONDUCTORS USING EPR AS A PROBE. Watkins, G. D. (General Electric Research and Development Center, Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 13-18(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The use of electron paramagnetic resonance (EPR) as a "microscopic" tool in the study of radiation-produced defects in semiconductors is discussed. The basic concepts of EPR and its general applicability to point defects in semiconductors are outlined. As an illustrative example, the study of a p-type (aluminum doped) silicon sample is described from 20.4°K irradiation with 1.5-MeV electrons through various annealing stages. By analysis of the EPR spectra, it is shown that the major defects can be identified and the annealing mechanisms determined. (auth)

5614 IMPURITY DEPENDENCE OF DEFECT INTRODUCTION AND ANNEALING IN ELECTRON IRRADIATED n-TYPE GERMANIUM. Cleland, J. W.; Paciesas, W. S. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 19-23(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Electron irradiation experiments on Si and Ge have indicated the creation of highly mobile interstitial atoms that in turn displace substitutional chemical impurity atoms (S) from the lattice; hence, the primary products of irradiation may be lattice vacancies (V) and interstitial chemical impurities (I). Subsequent annealing may then involve some type of interaction between (V) and (I). The relative amount of radiation damage, or ratio of (I) to the remaining substitutional chemical impurity atom concentration (S_R), is also expected to be of importance since there may be competition during annealing between (I) and (S_R) for the mobile (V). Samples of P, As, Sb, Sb-Ag, and Sb-Au doped n-type Ge of different initial carrier concentrations were irradiated at ~295°K with ~1.7-MeV electrons to different ratios of (I) to (S_R), and electrical property measurements were made at 77°K immediately after irradiation. The results indicate (1) an increase in the apparent rate of removal of conduction electrons for material of higher initial carrier concentration, (2) a difference in the apparent rate of removal for different dopants, (3) a small dependence of the apparent removal rate on the total amount of disorder introduced, and (4) the amount of annealing was not a sensitive function of the ratio of (I) to (S_R) for P or Sb-doped material, but was for As-doped material. (auth)

5615 INTERSTITIAL DEFECTS IN p-TYPE SILICON. Cherki, M.; Kalma, A. H. (Ecole Normalle Superieure, Paris). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 24-7(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Two defects introduced in boron- and aluminum-doped silicon by 1.5-MeV electron irradiation have been studied by means of infrared photoconductivity. The defects have been identified as being dopant atoms in interstitial positions. Stress-induced dichroism measurements have allowed the determination of the defects' symmetry which is C_{3v}. (auth)

5616 ANNEALING STUDIES OF DAMAGE INTRODUCED BY HIGH ENERGY ION IMPLANTATIONS OF SILICON. Roosild, S.; Dolan, R.; Buchanan, B. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 33-6(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Ion implantation of dopant impurities into semiconductors offers numerous potential advantages. However, because of the limited knowledge presently available on the annealing of lattice damage, the implantation profile and the electrical characteristics of implanted layers, a considerable amount of investigation is required before this doping technique can be put to practical use. Experimentally obtained implantation profiles and electrical conductivity characteristics of high energy (above 1 MeV) dopant ion implants into silicon are presented. Some preliminary results of ion implantation on silicon dioxide and on the resulting devices are also included. (auth)

5617 OBSERVATION OF CRYSTAL LATTICE PLANES IN NEUTRON AND ION BOMBARDED Ge. Parsons, J. R.; Hoelke, C. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 37-42(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa, (7 Jul 1969).

A review of the achievements of the Gossick and Crawford model of disordered regions in semiconductors is given, together with a transmission electron microscope investigation of the structural characteristics of the disordered regions themselves. Both diffraction contrast and phase contrast electron microscope images have been used to examine disordered regions observed in Ge irradiated with fast neutrons or 100 keV oxygen ions. Experimental evidence is presented which clearly demonstrates that the disordered regions have an amorphous rather than a defect rich crystalline structure. Furthermore, each disordered region is observed to be surrounded by a non-uniform strain field extending out to ~65Å from the disordered region center. (auth)

5618 NEUTRON FLUENCE AND ELECTRIC FIELD STRENGTH DEPENDENCIES OF THE RATE OF VOLUME DAMAGE INTRODUCTION IN SILICON P–N JUNCTIONS. Goben, C. A.; Irani, C. H.; Johnson, P. E. (Univ. of Missouri, Rolla). Contract AT(11-1)-1624. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 43-52(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The anomalous behavior of neutron-induced defect clusters in the high field space-charge region of silicon p–n junctions is investigated. The space-charge region recombination current variation with neutron fluence and the junction electric field strength present during irradiation is examined and an electric field strength dependence for the defect clusters is found to exist. The space-charge region rate of volume damage introduction is observed to be a function of both neutron fluence and the junction electric field strength present during irradiation. An empirical expression for the dependence of the rate of volume damage introduction on fluence and junction field strength present during irradiation is developed. Possible mechanisms for the observed field dependence are discussed. (auth)

5619 EFFECT OF 14 MeV NEUTRONS ON SPACE–CHARGE-LIMITED CURRENT OF ELECTRONS IN HIGH PURITY SILICON. Vu Thuong Quat; Nicolet, Marc-A. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 69-80(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Alloyed and symmetrical $n^+\nu n^+$ devices made of nominally 75 kΩcm ν-type Si are analyzed before and after irradiation with 14 MeV neutrons at room temperature and doses of 1.2×10^{11}, 5.5×10^{11} and 4.0×10^{12} n/cm^2. Immediately after the application of a large turn-on voltage step at $t \approx 0$, the flow of electrons through these devices is by pure, trap free, space-charge-limited current (sclc). From an analysis of this sclc, it is established that the drift velocity-field relationship of electrons in Si is affected by the radiation only at low temperatures in the low field range. For $t > 0$, the current after irradiation decays below its initial trap free sclc value, thus revealing the presence of traps. Two categories are identified: fast traps with energy levels at about $\Delta E_{tf} \approx 0.13$ eV below the conduction band and slow traps with energy levels at roughly $\Delta E_{ts} \approx 0.5$ eV. Cross sections are also obtained. Introduction rates are about equal for both (11 cm^{-1} for fast traps and 8 cm^{-1} for slow traps). These results demonstrate the sensitivity of sclc as a tool to detect traps and changes in the drift velocity-field relationship caused by radiation. Some implications of these results are discussed and additional experiments are suggested. (auth)

5620 RADIATION HARDENING OF THERMAL OXIDES ON SILICON VIA ION IMPLANTATION. Donovan, R. P. (Research Triangle Inst., Research Triangle Park, N. C.); Simons, M.; Monteith, L. K. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 203-6(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

Implantation of thermal oxide on silicon with 10^{16} N_2^+ cm^{-2} at an energy of 50 keV reduces the space charge buildup observed in the oxide when exposed subsequently to ionizing radiation. The component of radiation-induced charge buildup in the oxide attributable to the increase in fast surface states at the oxide-silicon interface is largely unaffected. (auth)

5621 MEASUREMENTS OF STRESS WAVES IN SOLIDS BY DYNAMIC PHOTOELASTICITY. Honnold, V. R.; Berggren, C. C.; Peffley, W. M. (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 6, 255-9(Dec 1969).

From Conference on nuclear and space radiation effects; University Park, Pa. (7 Jul 1969).

The technique of dynamic stress-birefringence has been applied in two unique ways to a study of stress waves in solids. Observations of both longitudinal and shear waves, induced in Plexiglas by a pulsed beam of high-energy electrons, have been made with a polariscope operating in the visible. Stress waves induced in silicon by an exploding wire facility were studied with the polariscope in the infrared. The theories of thermoelasticity and birefringence are reviewed briefly, and solutions describing stress induced by transient energy depositions are obtained. These solutions are compared with experimental results obtained with a flash x-ray generator. (auth)

5622 · DOSE DEPENDENCE AND PHOTOBLEACHING OF THE SOLVATED ELECTRON IN ALKALINE ICE. Kawabata, Keisuke; Okabe, Shigeru; Taniguchi, Setsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 89-96(1970).

The dose dependences of the ESR signal and optical spectra of the solvated electron in alkaline ice were examined. Their building up and their succeeding decrease are discussed, considering the filling process of the pre-exising traps. The photobleaching effects on the ESR and the optical spectra were also examined. The optical spectrum is composed of many elementary components (more than three) different in energy. The partial bleaching occurs at all wavelengths of the spectrum, even at 8500 Å. The mutual conversions between the elementary components by light were found. The elements have broad and asymmetrical spectra as in the original composed spectrum. The peaks are thought to vary from ir to about 5600 Å. (auth)

5623 BLOCKING OF ELECTRONS AND POSITRONS IN CRYSTALS. Pathak, A. P.; Yussouff, M. (Indian Inst. of Tech., Kanpur, India). pp 103-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

A one-phonon Debye model was used to calculate the electron and positron emission intensity pattern due to an emitter inside the crystal. The temperature and energy dependences were determined. The magnitudes of Re C_{ho} and Im C_{ho} are small compared to V_h, indicating that renormalization of the wave function does not change the intensity pattern appreciably and that at higher energies, inelastic processes do not participate in channeling and blocking. (D.L.C.)

5624 THERMOLUMINESCENCE OF QUENCHED LiF SINGLE CRYSTALS. Rao, S. Muralidhara (Bhabha Atomic Research Centre, Bombay). pp 225-30 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

The effects of quenching from 400 to 750°K on the glow curve were studied for commercial LiF and Mg–Ti-doped vacuum-distilled LiF crystals. 100 R from a ^{60}Co source was used. The low-temperature peaks can be explained by the dissolution of Mg^{2+} on heating and the formation of impurity–vacancy complexes on quenching. (D.L.C.)

5625 THERMOLUMINESCENCE OF KBr CRYSTALS. Murthy, K. R. N.; Murti, Y. V. G. S.; Ramasastry, C. (Indian Inst. of Tech., Madras). pp 239-44 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

A study was made of the thermoluminescence of KBr and KBr: Cu crystals in the temperature range 300 to 550°K following x irradiation. Four of the observed glow peaks were isolated and analyzed. Effects of tempering were studied. (D.L.C.)

5626 OPTICAL ABSORPTION INDUCED BY PROTON IRRADIATION IN MgO. Seiyma, Takeyoshi (Univ. of Minnesota, Minneapolis). Annu. Rep. Radiat. Center Osaka Prefect.; 11: 106-7(1970).

Proton irradiation (15 MeV, 5.7×10^{16} total number) introduces 560-, 362-, 354-, 346-, 3300-, and 3230-nm bands in MgO. The 354- and 362-nm bands are thought to be identical with the bands introduced by neutron irradiation. It seems that the 3300- and 3230-nm bands may be due to injection of protons. Proton irradiation is useful for study of color centers in MgO. (auth)

5627 PHOTOSENSITIVITY OF THE ESR SIGNAL AT $g_\perp$ = 2.0266 AND $g_{||}$ = 2.0545 OBSERVED IN ELECTRON-IRRADIATED ZnS. Shono, Yoshihiko; Kitagawa, Michiharu; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 104-5(1970).

A ZnS crystal irradiated with 8-MeV electrons showed an ESR signal at $g_\perp = 2.0266$ and $g_{||} = 2.0545$ at liquid nitrogen temperature after uv excitation. The signal was enhanced by 2.9-eV light, and grew further by 0.9-eV light. The quenching rate of the signal under illumination with 1.8-eV light was fastest just after uv excitation and slowest after illumination with 2.9-eV light in the sample annealed at 150°C for 20 minutes, the 2.9-eV light scarcely enhanced the signal, while the 0.9-eV light enhanced the signal prominently. The quenching rates were about the same as the ones obtained in the simply electron-irradiated sample, but about 40% of the initial magnitude of the signal remained. (auth)

5628 ISOTHERMAL ANNEALING IN ELECTRON-IRRADIATED CdS. Kitagawa, Michiharu; Yoshida, Toshio; Shono, Yoshihiko. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 102-3(1970).

The effects of isothermal annealing at 295°K on the temperature dependence of conductivity in a CdS single crystal irradiated by 10-MeV electrons were studied. The conductivity is decreased considerably with the irradiation in the whole temperature range between 77 and 295°K. The conductivity in the low-temperature range is hardly changed with isothermal annealing at 295°K, while that in the high-temperature range is increased. Especially the recovery around 130°K is conspicuous after annealing over 30 minutes. It is suggested that the change in conductivity around 130°K is due to a recovery not yet reported. (auth)

5629 $Ga_{1-x}Al_xAs$ PRODUCED BY Al^+ ION IMPLANTATION OF GaAs. Hunsperger, R. G.; Marsh, O. J. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett.; 19: No. 9, 327-9 (1 Nov 1971).

GaAs was converted to $Ga_{1-x}Al_xAs$ by implanting GaAs substrates with 30-keV Al^+ ions and subsequently annealing at 900°C. The maximum ion dose used was 2×10^{16} cm^2, corresponding to a calculated peak concentration of approximately 10^{22} Al atoms/cm^3. The emission spectra of electroluminescent diodes formed in the material were measured. (auth)

5630 EFFECT OF ILLUMINATION OF THE MICROTOPOGRAPHY MODIFICATIONS OF NaCl AND KCl SURFACES IRRADIATED WITH ELECTRONS AND GAMMA OR X RAYS. Agarbiceanu, Ion I.; Arsenovici, Leona C.; Teodorescu, Ion A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 7, 669-75(1971).

The effect of light on the microtopography transformation of pure and doped NaCl and KCl single crystals irradiated with gamma or x rays, as compared with electron-bombarded speci-

mens, was studied. After illumination of electron-bombarded samples, a polygonization process occurs, but not gamma- or x-irradiated crystals; instead, the microrelief is strong and ununiformly changed. Both effects are caused by the illumination, which modifies the color centers and helps the superficial defects to move. These microtopography transformations are not efficiently influenced by thermal annealing or by the atmosphere in which specimens are kept. (auth)

5631 INFRARED ABSORPTION IN n-SILICON IRRADIATED WITH DIFFERENT DOSES OF FAST NEUTRONS. Groza, A. A.; Nikolaeva, L. G. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 794-8(May 1971). (In Russian).

The effect of fast-neutron irradiation with different doses in n-Si was examined by infrared absorption techniques. The doses varied in the range of 4.5×10^{16} to 10^{19} neutron/cm^2. It was revealed that dominant types of damages with large and small doses were different. The clusters of defects predominate with large doses of irradiation. (auth)

5632 EFFECT OF IRRADIATION BY 35- TO 250-MeV ELECTRONS ON DISLOCATION MOBILITY IN LITHIUM FLUORIDE SINGLE CRYSTALS. Garber, R. I.; Mikhailovskii, V. M.; Malik, A. K.; Stratienko, V. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 757-61(May 1971). (In Russian).

The range of dislocations created under the action of point loads was studied as a function of irradiation parameters. It was found that the radiation defects decrease considerably the dislocation range. The radiation damage is thermally stable up to 400°C and completely disappears at 600°C. (auth)

5633 INVESTIGATION OF THE FREQUENCY DEPENDENCE OF SPIN–LATTICE RELAXATION TIME IN NEUTRON-IRRADIATED QUARTZ. Shamfarov, Ya. L.; Smirnova, T. A. (Inst. of Radio Physics and Electronics, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 600-2(Apr 1971). (In Russian).

The spin–lattice relaxation time dependence on application of an external magnetic field (frequency) at 4.2°K was investigated. It is shown that the spin–lattice relaxation time grows with magnetic increase. The latter indicates the presence of cross-relaxation. (auth)

5634 DEFECTS IN NEUTRON-IRRADIATED ZnO. II. Leutwein, K.; Schneider, J. (Institut fuer Angewandte Festkoerperphysik, Freiburg i. B.). Z. Naturforsch.; 26a: No. 8, 1373-5(Aug 1971).

By ESR, it was observed that fast-neutron irradiation of iron- and copper-doped ZnO results in association of diamagnetic lattice defects with the 3d-impurity ions. (auth)

5635 ELECTRON SPIN RESONANCE STUDIES OF HOLES TRAPPED AT Mg^{2+}, Li^{+}, AND CATION VACANCIES IN Al_2O_3. Cox, R. T. (CEN, Grenoble, France). Solid State Commun.; 9: No. 22, 1989-92(15 Nov 1971).

Fully ionized acceptor defects were introduced into alpha Al_2O_3 crystals by compensated doping. Gamma irradiation converted these to paramagnetic charge states, which were studied by ESR. The spectra of the S = ½ centers Mg_{Al}, Li'_{Al} and V''_{Al} and of the S = 1 centers Li_{Al} and V'_{Al} are interpreted in terms of highly localized holes. (auth) (UK)

5636 COLOR CENTERS IN γ-IRRADIATED ALKALI HYDRATES AT 77°K. Ershov, B. G.; Puntezhis, S. A.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 168-9(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 185-6(Mar-Apr 1971).

The formation of electron centers during γ-radiolysis of crystalline alkali hydrates at 77°K was studied. Emphasis was placed on $NaOH \cdot 3.5H_2O$, although $LiOH \cdot H_2O$, $NaOH \cdot 7H_2O$, $KOH \cdot 2H_2O$, and $KOH \cdot 4H_2O$ were also studied. The irradiation at 77°K produced a red or reddish orange color; $NaOH \cdot 3.5H_2O$ has its absorption maximum at 490 ± 5 nm. The color centers are bleached by light, and heating to above 130°K increases the initial absorption and shifting the band to longer wavelengths; a new band at 550 ± 20 nm is also produced. The EPR spectrum has two signals, one of which disappears on illumination and reappears on subsequent heating. This EPR signal and the absorption spectrum apparently relate to electrons captured in anion vacancies (F centers). The molar extinction coefficient for an electron center was calculated to be 2.12×10^4 l/mole-cm at 490 nm, and the yield is 0.05 and 0.1/100 eV at 77 and 195°K, respectively, as compared with the yield of 2 to 3/100 eV in aqueous glass. (D.L.C.)

5637 HETEROGENEOUS RADIOLYSIS OF SEMICONDUCTORS AND DIELECTRICS. Krylov, O. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 160-1(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 179-80(Mar-Apr 1971).

A theoretical discussion is given of the radiolysis of adsorbed substances in metals, semiconductors, and dielectrics. The threshold value of the forbidden band and the current carrier diffusion are discussed. Electron-capture modes are considered. A graph of catalytic activity vs width of forbidden band is given for CH_3OH radiolysis in charcoal and various oxides. (D.L.C.)

5638 STUDIES ON NONMETALS DURING IRRADIATION: IV. EFFECT OF STRAIN APPLIED DURING IRRADIATION ON GAMMA-RAY-INDUCED F-CENTER COLORING OF KCl AT ROOM TEMPERATURE. Levy, P. W.; Mattern, P. L.; Lengweiler, K.; Goldberg, M. (Brookhaven National Lab., Upton, N. Y.). Solid State Commun.; 9: No. 22, 1907-12(15 Nov 1971).

KCl F-center coloring curves measured at room temperature on unstrained crystals contain one linear and three saturating exponential components. After deformation beyond 0.25%, the coloring is markedly increased, and is described by a linear term and two exponential components. The post-strain coloring curves can be reconstructed from the measured parameters with strain the only independent variable. These observations indicate that the strain-related coloring depends on dislocation content. (auth) (UK)

5639 TEMPERATURE DEPENDENCE OF THE EARLY STAGES OF F-CENTER PRODUCTION BY PROTON BOMBARDMENT OF NaCl AND KI CRYSTALS. Alekseev, P. D.; Vaisburd, D. I. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 145-7(1971). (In Russian).

F-center production in ionic crystals occurs chiefly through the interaction of low-energy electron excitation with structural defects. If the diversity of electron excitation (electrons, holes, excitons, etc.) of internal and contaminant defects is taken into account, then the number of conceivable mechanisms appears enormous. This problem was investigated by measuring the temperature dependence of separate components with 3.5-MeV protons (4.2×10^{10} p/cm$^2 \cdot$ sec). The yield of F centers was maximal at 130°K for slow (linear) stages, and 230°K for fast stages in KI crystals. The presence of OH^- in such crystals has little effect in the first case but increases the saturation level in the second case. (K.S.W.)

Physical Properties

Refer also to abstracts 4556, 4954, 4970, and 5389.

5640 (CONF-710337–1) MAGNETIC PROPERTIES AND MAGNETIC STRUCTURES OF Tb_3Al_2 AND Dy_3Al_2. Barbara, D.; Decle, C.; Lemaire, R. (Centre National de la Recherche Scientifique, Grenoble (France). Laboratoire d'Electrostatique et Physique du Metal). 22 Oct 1971. 11p. (In French). Dep. NTIS (U. S. Sales Only).

From Conference on magnetism; Salzburg, Austria (29 Mar 1971).

The compounds Tb_3Al_2 and Dy_3Al_2 crystallize with a Hf_3Al_2-type structure, the ordering temperatures being 190 and 76°K, respectively. Between 190 and 10°K, Tb_3Al_2 exhibits a ferromagnetic behavior; below this temperature, the magnetization does not vary ferromagnetically with the field. The magnetic structures determined between 4.2 and 77°K show a strong ferromagnetic component parallel to the c axis of the cell. Magnetic measurements effected on a single Dy_3Al_2 crystal show that ferromagnetic behavior exists between 76 and 20°K. Below this temperature, the first magnetization loop does not resemble that of a ferromagnetic material. A structure with a strong ferromagnetic component parallel to the c-axis enables the neutron-diffraction patterns obtained between 4.2 and 47°K to be explained. The magnetic properties of Dy_3Al_2 can be explained using a new magnetization process in correlation with the existence of thin walls between the magnetic domains. The anisotropy and exchange conditions corresponding to walls in Dy_3Al_2 are no longer fulfilled with Tb_3Al_2. (France)

5641 (CONF-711108–2) MAGNON ENERGY SPECTRUM IN FERROMAGNETIC Dy. Nicklow, R. M.; Wakabayashi, N. (Oak Ridge National Lab., Tenn.). [1971]. 4p. Dep. NTIS.

From nineteenth conference on remote systems technology; Miami Beach, Fla. (17 Oct 1971).

The energy spectrum of magnons propagating along the [001] and [110] directions in ferromagnetic dysprosium at 4.7 and 78°K was determined by triple-axis neutron spectrometry. Throughout this temperature range, the measured energy gap at zero wave vector ($\vec{q} \rightarrow 0$) is approximately 40% larger than that calculated from the macroscopic magnetostriction and crystal-field anisotropy constants. Although the magnon energies increase with decreasing temperature, the variation near $\vec{q} = 0$ is much stronger

than that near the Brillouin zone boundaries. Thus, the magnitude of the exchange interaction decreases substantially, ~25% in the c-direction, between 78 and 4.7°K. Significant magnon–phonon interactions are observed, particularly in the [110] direction, where the acoustic magnon branch appears to be mixed with both the longitudinal and transverse acoustic phonon branches. (auth)

5642 (UJV–2689–M) HYDROTHERMALLY FORMED CRYSTAL PHASES IN THE SYSTEM UO_3/H_2O. Urbanec, Z.; Jarchovsky, T. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

Crystals prepared under hydrothermal conditions at 100 to 300°C from a water suspension of $UO_3 \cdot H_2O$ or $UO_4 \cdot 2H_2O$ and from a solution of uranyl acetate were examined by means of infrared spectroscopy and by measurement of optical parameters. According to the measurement of optical indicatrix orientation, it is concluded that the rod-shaped α-modification of $UO_2(OH)_2$ must be monoclinic, in contradiction with the earlier determination by x-ray diffraction. Both spectroscopic and optical data show a structure difference of the α-modification and crystals formed by pressure-induced transformation of the β-modification. On the other hand, a relationship between β- and ϵ-$UO_2(OH)_2$ is indicated. Characteristic parameters for UO_3 hemihydrate are presented. (auth)

5643 EFFECTIVE MAGNETIC FIELDS AT NUCLEI OF LANTHANUM DISSOLVED IN GADOLINIUM. Nikulin, E. I.; Patrikeev, Yu. B. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 999-1000 (Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1206-7(Apr 1971).

The specific heat of Gd–La solid solutions was measured over the entire composition range at 0.06 to 0.16°K and used to calculate the effective magnetic fields H_{eff} at the La nuclei. The appearance of H_{eff} at the La nuclei in antiferromagnetic alloys in the middle of the composition range is attributed to the polariza- of the s electrons in the filled shells by the localized magnetic moment. (D.L.C.)

5644 EFFECTIVE MAGNETIC FIELDS AT NUCLEI OF VANADIUM DISSOLVED IN IRON. Nikulin, E. I.; Fogt, K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 1001-2(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 1207-9(Apr 1971).

The specific heat of $Fe_{1-x}V_x$ alloys ($0.1 \leq x \leq 0.7$) was measured at low temperatures (0.09 to 0.3°K) in order to determine H_{eff} at the V nuclei. The H_{eff} vs composition curve was found to fit a straight line $H_{eff} = (87.1 - 111x)$kOe for the α-phase samples. For a 40 at. % V sample annealed at 950°C to give a σ phase, H_{eff} was determined to be 24 kOe, as compared with the 42-kOe value for the α phase. The local field due to the interaction between the magnetic moment of the nucleus and the local magnetic moment of the electron shells of the same atom was calculated to be −14 to −12 kOe for V. The local magnetic moment of V is 0.1 μ_B. (D.L.C.)

5645 EFFECT OF HYDROSTATIC PRESSURE ON THE ELECTRICAL CONDUCTIVITY OF THE OXIDE EuO. Sokolova, G. K.; Samokhvalov, A. A.; Rodionov, K. P. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 1042-3(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1244-6(Apr 1971).

The electric conductivity σ of EuO single crystals was measured under pressure up to 20 kbars from room temperature down to 70°K. σ increases exponentially with pressure, and the slope of log σ vs 1/T decreases with pressure according to $dE_\alpha/dp = -5.0$ MeV/kbar. The conductivity (which is of the impurity type) change is due to a decrease in the ionization energy of the impurity and to lowering of the bottom of the 5d t_{2g} zone. (D.L.C.)

5646 DOMAIN-WALL ENERGY AND COERCIVE FORCE OF COBALT-RARE-EARTH PERMANENT MAGNET MATERIALS. Westendorp, F. F. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys.; 42: No. 13, 5727-31(Dec 1971).

Domain structures in RCo_5 compounds were observed with Kerr effect in fields up to 8000 Oe. The domain structures in $SmCo_5$ are much coarser than in the other compounds. It is shown that this difference may be due to a higher wall energy in $SmCo_5$. The idea is developed that this higher wall energy is responsible for the higher coercivities of $SmCo_5$. (auth)

5647 LAYERING IN SPUTTERED TANTALUM FILMS. Waterhouse, Neil (Bell-Northern Research, Ottawa). Appl. Phys. Lett.; 19: No. 10, 375-8(15 Nov 1971).

It has been reported in the literature that the electrical properties of some sputtered tantalum films vary with depth in the film and that this might be due to the formation of "layers" during deposition. The characteristics of a simple two-layer model have, therefore, been examined using existing electrical data to determine the functional dependence of the layer resistivity on temperature. The predictions of this model agree quite well with experimental data for a sample exhibiting "peaked" resistivity-vs-temperature characteristics. Layer thicknesses used in the prediction are compatible with a previously proposed layering mechanism. Attempts to predict the experimental data using a simplified dual conduction mechanism were unsuccessful when equation constants close to physically measured values were used. Possible reasons for this disagreement are discussed. (auth)

5648 CURRENT TRANSPORT, EFFECTIVE DIELECTRIC CONSTANT, AND TEMPERATURE OF Ta_2O_5 THIN FILMS. O'Clock, George D. Jr. (RCA Advanced Tech.Labs., Van Nuys, Calif.). Appl. Phys. Lett.; 19: No. 10, 403-5(15 Nov 1971).

The I–V characteristics of Ta/Ta_2O_5/Au thin-film devices indicate high temperatures and large dielectric constants for both Schottky and Poole–Frenkel-dominated conduction. The effects of space charge and electron effective mass are also indicated. (auth)

5649 EXPERIMENTAL STUDY OF THE SPECIFIC ELECTRIC RESISTIVITY OF SINGLE-CRYSTAL MOLYBDENUM IN THE HIGH-TEMPERATURE RANGE. Peletskii, V. E.; Druzhinin, V. P. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 1, 70-3(Jan-Feb 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 1, 85-9(Jan-Feb 1971).

A description is given of the special features of a new design of the working part of the apparatus which enable the reliability of operation to be increased by a compensation method, using electron heating for the specimen. Results are reported of a study of the specific electrical resistivity of specimens of single-crystal and polycrystalline vacuum-remelted molybdenum in the range 300 to 2500°K. (auth)

5650 TWO COMPONENTS OF THE CRYSTALLOGRAPHIC TRANSITION IN VO_2. Goodenough, John B. (Massachusetts Inst. of Tech., Lexington). J. Solid State Chem.; 3: No. 4, 490-500(Nov 1971).

Two distinguishable mechanisms of the monoclinic-to-tetragonal transition in VO_2 are identified: an antiferroelectric-to-paraelectric transition at a temperature T_t as well as a change from homopolar to metallic V–V bonding at a temperature T_t'. In pure VO_2 at atmospheric pressure, the two transitions occur at the same temperature, $T_t = T_t = 340$°K. However, a $T_t' < T_t$ may be induced by atomic substitutions, and in the intermediate temperature range the structure is orthorhombic, the antiferroelectric distortions being somewhat different in the absence of homopolar V–V bonding. From energy-band considerations, the semiconductor-to-metal transition is to be associated with the transition at T_t; but below T_t' the semiconducting energy gap should be larger and the charge-carrier mobilities should be smaller. The existence of two transition temperatures in doped VO_2 is distinguished from the claim of two transition temperatures in the Magnéli phases V_nO_{2n-1}. In this latter case, the appearance of two transitions reflects a two-phase region consisting of two adjoining Magnéli phases. (auth)

5651 DISAPPEARANCE OF THE LOCAL MAGNETIC MOMENT OF Ce IN LIQUID Co–Ce ALLOYS. Doriot, P. A.; Guentherodt, H.-J.; Schlapbach, L. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 37A: No. 3, 213-14 (22 Nov 1971).

The magnetic susceptibility of liquid Co–Ce alloys was measured. In the middle of the concentration range, the magnetic susceptibility shows a minimum and the local magnetic moment of Ce disappears. (auth)

5652 CALCULATION OF THE CURIE TEMPERATURE OF Pr NUCLEI IN THE INTERMETALLIC COMPOUND, $PrTl_3$. Landesman, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 32: No. 8, 671-7(Aug 1971). (In French).

The Curie temperature of Pr nuclei in the intermetallic compound, $PrTl_3$, is calculated. The Pr nuclei are coupled by indirect interactions through collective paramagnetic electronic excitations. The temperature calculated is close to that observed by Andres and Bucher. (France)

5653 DIVERGENT MAGNETIC COEFFICIENT OF RESISTIVITY, $d\rho/dH$, OF A FERROMAGNET CeAg AT T_c. Bakanowski, S.; Fote, A.; Mihalisin, T. (Temple Univ., Philadelphia). Phys. Lett.; 37A: No. 3, 195-6(22 Nov 1971).

Measurements of the electrical resistivity, $\rho(H,T)$, of ferro-

magnetic CeAg indicate that $d\rho(H,T_c)/dH$ diverges as H^{-x} with $x = 0.63 \pm 0.05$. The roles of both coherent and incoherent scattering are discussed. (auth)

5654 MAGNETORESISTANCE EFFECT IN SINGLE CRYSTALS OF Gd. Hiraoka, Takeshi; Suzuki, Morio (Saga Univ., Japan). J. Phys. Soc. Jap.; 31: No. 5, 1361-5(Nov 1971).

Orientational and forced magnetoresistances were measured on Gd single crystals in a range from 77 to 400°K. According to a phenomenological analysis, the four anisotropy constants of the orientational magnetoresistance were determined. The temperature dependence of the orientational magnetoresistance showed generally two minima and a maximum, while the constants showed single minimum. This appears to be attributable partly to the variation of the easy direction with temperature. The temperature dependence of the forced magnetoresistance also was anisotropic. This seems to be related to the variation of the electrical resistance with temperature. (auth)

5655 ANOMALOUS HALL RESISTIVITY OF MONOCRYSTALLINE GADOLINIUM AND ITS PRESSURE EFFECT. Sawaoka, A.; Tomizuka, C. T. (Univ. of Arizona, Tucson). Contract AT(11-1)-1041. Phys. Lett.; 37A: No. 3, 211-12(22 Nov 1971).

The Hall resistivity of monocrystalline gadolinium at 210, 273, and 295°K was measured at pressures up to 6 kbar. The absolute value of resistivity decreases with increasing pressure. The decrease is explained qualitatively to be the result of a transition of 4f-electrons to the 5d state. (auth)

5656 MAGNETIC CHARACTERISTICS OF SOME TERNARY INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES. Wallace, W. E.; Volkmann, T. V.; Hopkins, H. P. Jr. (Univ. of Pittsburgh). J. Solid State Chem.; 3: No. 4, 510-14(Nov 1971).

Magnetic characteristics are given for the five ternary systems $Ln_xLn'_{1-x}Co_5$ with the combinations Gd and Nd, Dy and Pr, Dy and Nd, Gd and Dy, and Gd and Ho, and for the ternary $Dy(Co_xNi_{1-x})_5$. Curie temperatures (T_c) of the Ln–Ln′–Co ternaries range from 912 to 1008°K. Replacement of Co by Ni in $DyCo_5$ decreases T_c to 63°K in $DyCoNi_4$. Magnetization-temperature and the magnitude of saturation moment indicate the Ln–Ln′–Co ternaries to be ferrimagnets; the Ln–Co (or Ln′–Co) coupling is ferromagnetic when Ln = Pr or Nd and antiferromagnetic when Ln = Gd, Dy, or Ho. The magnetic behavior of the Dy–Co–Ni ternaries indicates that they are also ferrimagnetic. Nickel in these ternaries, unlike Ni in $DyNi_5$, is magnetic. The moments indicate a nickel moment ranging from 0.16 to 0.49 μ_B per atom and with Dy coupled antiparallel to Ni and Co. (auth)

5657 MAGNETIC PROPERTIES OF RARE EARTH–LEAD INTERMETALLICS. Hutchens, R. D.; Wallace, W. E. (Univ. of Pittsburgh). J. Solid State Chem.; 3: No. 4, 564-6(Nov 1971).

Magnetic susceptibilities of the series of intermetallics represented by the formula RPb_3(R = Ce, Pr, Nd, Sm, Eu, and Gd) are reported for temperatures ranging from 2.8 to 300°K. Curie–Weiss behavior is noted for all compounds except $SmPb_3$ with slopes in good agreement with that expected for assemblages of free tripositive ions (dipositive for $EuPb_3$). The behavior of $SmPb_3$ is in accordance with the behavior usually observed for Sm compounds and is due to the narrowness of the multiplet spacing in the tripositive samarium ion. $PrPb_3$ exhibits Van Vleck paramagnetism below 15°K; its susceptibility–temperature behavior is analyzed in terms of an overall crystal field splitting of 80°K. Results indicate the possible onset of antiferromagnetism at 17 and 22°K for $GdPb_3$ and $EuPb_3$, respectively. The other compounds give no indication of forming a cooperative magnetic phase at temperatures down to 2.8°K. (auth)

5658 GALVANOMAGNETIC PROPERTIES OF SOLID REFRACTORY COMPOUNDS OF GROUP IVA METALS IN A TWO-ZONE REPRESENTATION. Malinskii, B. I.; Nemchenko, V. F.; L'vov, S. N. (Kherson State Coll., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 84-8(1971). (In Russian).

The application of galvanomagnetic theory for metals to the field of metal-like compounds is investigated on the basis of a study of the galvanomagnetic properties of some refractory compounds of Group IVA metals. Experimental data indicate that a two-zone model provides more definite conclusions regarding the mechanism of the electric conductivity of the compounds studied. Experimental data for the Hall and Ettingshausen–Nernst effects in ZrC and ZrH_2 at 78 and 300°K are discussed. (tr-auth)

5659 HALL EFFECT AND THE MAGNETORESISTANCE OF TITANIUM AND ZIRCONIUM NITRIDES. Malinskii, B. I.; Nemchenko, V. F.; L'vov, S. N. (Kherson State Teachers Coll., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 134-7(1971). (In Russian).

Many refractory compounds of metals of Group IVA possess metal-like electric conductivity. Analogously, the magnetoresistance and the Hall effect were investigated in the nitrides of Ti and Zr at room temperature and at liquid N temperature. The experimental data and parameters derived from those data agree satisfactorily with the two-zone representation of an electric conductivity mechanism. (K.S.W.)

5660 THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND THERMOPOWER OF AEROSPACE ALLOYS FROM 4 TO 300 K. Hust, J. G.; Weitzel, D. H.; Powell, R. L. (National Bureau of Standards, Boulder, Colo.). J. Res. Nat. Bur. Stand.; 75A: No. 4, 269-77(Jul-Aug 1971).

Thermal conductivity, electrical resistivity, and thermopower were measured for several aerospace alloys: titanium alloy A110–AT, aluminum alloy 7039, Inconel 718, and Hastelloy X. Tables and graphs of the measured properties and Lorentz ratio are presented over the range 4 to 300°K. Comparisons to other measurements and theoretical analysis of the data are included. The uncertainties of the property data are estimated as (1) 0.7 to 2.5% for thermal conductivity, (2) 0.25% in electrical resistivity, and (3) about 0.1μ V/°K in thermopower. (auth)

5661 THEORY OF THE RESISTIVITY OF HIGH-CONCENTRATION INTERSTITIAL ALLOYS WITH APPLICATION TO THE TANTALUM–HYDROGEN AND TANTALUM–DEUTERIUM SYSTEMS. Pryde, J. A.; Tsong, I. S. T. (Sir John Cass Coll., London). Acta Met.; 19: No. 12, 1333-8(Dec 1971).

Changes in electric resistivity of tantalum filaments containing dissolved hydrogen and deuterium were measured as a function of concentration and temperature. The light atoms were regarded as forming a binary interstitial alloy with the metal and the resistivity changes were interpreted in terms of Nordheim's theory of the residual resistivity of substitutional alloys, but modified so as to apply to interstitial alloys. The modified theory predicted a parabolic variation of resistivity with concentration in the high-temperature disordered solid solution phase, in agreement with experiment. A sharp resistivity minimum in the ordered low-temperature phase at concentrations close to Ta (H or $D)_{0.5}$ was attributed to the formation of a superlattice of the light atoms, in agreement with neutron-diffraction data. (auth)

5662 DE HAAS–VAN ALPHEN EFFECT IN LUTETIUM. Hoekstra, J. A.; Phillips, R. A. (Iowa State Univ., Ames). Phys. Rev., A; 4: No. 6, 4184-6(Dec 1971).

de Haas–van Alphen oscillations have been observed in lutetium single crystals using high impulsive magnetic fields. A single-frequency branch is reported which has a minimum value of 3.75 MG along the c axis and extends ~22° in both the $(1\bar{2}10)$ and $(\bar{1}100)$ planes. Comparison of the experimental results with the relativistic-augmented-plane-wave Fermi surface of Loucks suggests that the electron columns are pinched off at the symmetry point H. (auth)

5663 MAGNETIC SUSCEPTIBILITY OF WO_2–TiO_2 SOLID SOLUTIONS. Ariya, S. M.; Balashova, E. P. (Leningrad State Univ.). Vestn. Leningrad Univ., No. 4, Fiz., Khim.; No. 1, 57-60(Feb 1971). (In Russian).

It was found that WO_2 forms solid solutions with TiO_2 at least up to 3 wt % WO_2. Magnetic susceptibilities of the samples were measured in the temperature interval 80 to 470°K. The effective magnetic moment of tungsten at maximum dilution appeared to be close to the "only-spin" value for the $5d^2$ configuration 2.84 μ_B. (auth)

5664 FINE STRUCTURE OF L-ABSORPTION EDGES OF RHENIUM. Gupta, S. N. (Vikram Univ., Ujjain, India); Padalia, B. D. Physica; 54: No. 3, 342-6(15 Sep 1971).

The extended fine structure of L-absorption edges of rhenium was investigated, using 40- and 100-cm curved-crystal spectrographs, both of the transmission-type. It was found that the fine structure extends up to several hundred electron volts on the high-energy side of the principal absorption discontinuities. The present results agree with Hayasi's theory. (auth)

5665 DE HAAS–VAN ALPHEN EFFECT IN ReO_3. Phillips, R. A.; Shanks, H. R. (Iowa State Univ., Ames). Phys. Rev., B; 4: No. 12, 4601-5(15 Dec 1971).

The de Haas–van Alphen effect in ReO_3 single crystals was studied in detail using large impulsive magnetic fields. In addition to the three frequency branches reported by Graebner and Greiner and by Marcus, three new frequency branches were detected. All of the frequencies observed are in good agreement with the augmented-plane-wave calculation of Mattheiss. (auth)

5666 PLANE-WAVE–GAUSSIAN ENERGY-BAND STUDY OF Nb. Euwema, R. N. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., B; 4: No. 12, 4332-41(15 Dec 1971).

The numerical accuracy of the plane-wave-Gaussian (PWG) mixed-basis method of calculating crystalline energy bands is displayed for Nb. Atomic studies involving the Gaussian basis and crystalline studies involving the PWG mixed basis are systematically developed to establish the dependence of the energy eigenvalues upon the number of Gaussians, the number of plane waves, and the Gaussian overlap parameter. Use of the Nb crystalline potential of Deegan and Twose allows comparison with their results. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 4574, 4578, 4613, 4614, and 4616.

5667 (INP-747) THIRD ALL-POLISH SEMINAR ON NUCLEAR MAGNETIC RESONANCE AND ITS USE, KRAKOW, POLAND, DECEMBER 1-2, 1970. (Institute of Nuclear Physics, Krakow (Poland)). Dec 1970. 172p. (In Polish). (CONF-701216).

Texts of full papers are presented on: radiospectroscopic study of ferroelectrics; measurement of NMR spectra of NH_4 groups at liquid-He temperatures; resonance line shapes; future development of NMR apparatus; magnetic induction meter for direct reading of magnetic field units; sampling voltmeter (box-car); study of internal stress in crystals by nuclear resonance methods; NMR applications in petroleum chemistry and geochemistry; limitations in application of nuclear resonance techniques to interpretation of changes in conformation of biopolymers in solution; analysis of water content of collagen compounds by NMR line-width method; contact displacement in transition-metal solid solutions; and evaluation of internal calibration instruments in proton magnetic resonance at high resolving power. Abstracts or summaries are given for: resonance line widths, Knight shifts, and quadrupole coupling of ^{11}B in UB_2, UB_4, and UB_{12}; measurement of relaxation time T_1 of 2-dichloroethane dissolved in CCl_4; effect of multipole interactions on relaxation times in NMR; and possibility of detection of octupole magnetic resonance. (L.M.T.)

5668 (NP-19006) HYPERFINE INTERACTIONS OF RADIOACTIVE IMPURITIES IN IRON. Inia, Pieter (Groningen Rijksuniversiteit (Netherlands)). 1971. 78p. Dep. NTIS (U. S. Sales Only).

Thesis.

A study is made of the magnetic hyperfine fields of various impurity atoms embedded in an iron lattice. A brief description of the theoretical understanding of impurity magnetic hyperfine interaction is given. After a discussion of the theory and experimental methods, perturbed-angular-correlation measurements for ^{99}Tc, ^{67}Zn, and ^{203}Tl in Fe, and Moessbauer measurements for ^{161}Dy implanted in Fe and Cu are reported. (D.L.C.)

5669 SHAPE OF THE MAGNETIC RESONANCE LINES FROM ELECTRON-NUCLEAR LEVELS IN METALS AND INTERMETALLIC COMPOUNDS. Tsarevskii, S. L. (Kazan State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 4, 814-19(Oct 1971).

Translated from Fiz. Tverd. Tela; 13: No. 4, 976-82(Apr 1971).

The effect of spin exchange between the conduction electrons and the ions (rare-earth and iron group) on the width and shape of the magnetic resonance lines of electron-nuclear levels of these ions is treated. Effective nuclear and electron-nuclear Hamiltonians are constructed which describe this interaction. An equation is found for the longitudinal relaxation time T_1 of the effective nuclear moments of these ions in a magnetic field. It is shown that in the observed fields for intermetallic compounds of the RX type (R = Tm, Pr; X = N, P, As, Sb, Bi, S) the linewidth δH at temperatures $T \gtrsim 4.2°K$ is determined by T_1, and also depends linearly on the external magnetic field H with the tangent of the slope being $\delta H(H) \sim 3.2 \times 10^{-2}$ for TmX and $\sim 5.8 \times 10^{-2}$ for PrX. With increasing temperature, the relation between δH and H becomes imperceptible. The nuclear ordering temperature is estimated to be $\sim 3 \times 10^{-3}$ °K for PrBi on the basis of the effective spin-nuclear Hamiltonian found. With $N_1/N \sim 10^{-2}$ (N_1 is the number of nuclei which participate in the resonance and N is the number of lattice sites) and $T \gtrsim 1°K$, the width of the line is determined by the spin-spin interaction and is independent of T and H. The effective spin-spin exchange between nuclei due to the interaction with conduction electrons which is of interest is isotropic or anisotropic depending on the symmetry of the crystal field. (auth)

5670 NGR STUDY OF DYSPROSIUM DIHYDRIDE AT LOW TEMPERATURES. Hess, J.; Bauminger, E. R.; Mustachi, A.; Nowik, I.; Ofer, S. (Hebrew Univ., Jerusalem). Phys. Lett.; 37A: No. 3, 185-6(22 Nov 1971).

From a Moessbauer study of DyH_2($T_N \sim 8°K$) at low temperatures it is concluded that even at 0.23°K, two Dy^{3+} ionic levels are populated. The magnetic moments of the two levels, the splitting between them, and relaxation times are estimated from the experimental results using a simple model. (auth)

5671 MEASUREMENT OF THE HYPERFINE FIELD CONTRIBUTION TO QUANTUM TRANSPORT BY NMR EXCITATION. Sapoval, B.; Kaplan, D.; Lampel, G. (Ecole Polytechnique, Paris). Solid State Commun.; 9: No. 18, 1591-3(15 Sep 1971).

Electron-nucleus hyperfine interaction produces a measurable effect on resistivity in quantizing magnetic fields. The hyperfine field contribution was measured in n-type InSb at 1.2°K from the dc resistivity change triggered by nuclear magnetic resonance. The dependence of this effect on the external field exhibited a new type of Shubnikov-de Haas oscillations. Detection of NMR in extremely small samples was discussed. (auth) (UK)

5672 MAGNETIC RESONANCE IN METALS. Winter, J. International Series of Monographs on Physics. Oxford; Oxford University Press (1971). 304p. £5.50.

The subject is considered under the headings: short review of the properties of nuclear magnetic resonance, the hyperfine interaction, some properties of the metallic state, theoretical study of the nuclear resonance properties of metals, quadrupolar effects in perfect metals, results of nuclear magnetic resonance experiments in metals, nuclear resonance in nonperfect metals (alloys, liquid metals, and liquid alloys), nuclear resonance in metals and alloys with transition elements, nuclear resonance in superconductors, and the spin resonance of conduction electrons. In appendices, relations between susceptibilities and correlation functions and nuclear relaxation in transition metals are given. (UK)

Theory

Refer also to abstract 5681.

5673 THEORETICAL FORMULATION FOR LATTICE DYNAMICS OF HCP METALS. Kushwaha, S. S. (Banaras Hindu Univ., India). Phys. Lett.; 37A: No. 3, 193-4(22 Nov 1971).

A four-neighbor noncentral force model including ion-ion central, ion-ion angular, and ion-electron interactions has been presented. The calculated frequencies in the case of beryllium and thallium are periodic in the reciprocal space and compare well with the experimental data. (auth)

5674 RESISTANCE MINIMUM OF LUTETIUM FILMS. Upadhyaya, U. N. (Univ. of Udaipur, India). pp 43-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

Lazerev, Kuzmento, and Sudovtsov reported a resistance minimum in Lu films. A new mechanism for electron scattering is suggested that takes into account the distorted crystal lattice. It is assumed that the local distortions are distributed randomly and that the distortion field acts as a perturbation that mixes the d and s orbital state. (D.L.C.)

5675 CONDUCTION-ELECTRON DENSITY AT THE NUCLEUS IN DYSPROSIUM METAL. Ray, D. K. (Univ. Paris, Orsay, France); Das, K. C. pp 63-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

The conduction-electron density was calculated using the nonrelativistic augmented-plane-wave method. The value at the nucleus was found to be 0.532×10^{26} cm^{-3}, in comparison with the value of $(1.65 \pm 0.35) \times 10^{26}$ cm^{-3} found from Moessbauer isomeric shift measurements. Relativistic effects and finite nuclear size may be taken into account by multiplying the calculated value by 4, which improves the agreement with the experimental value. (D.L.C.)

5676 EFFECT OF THE CRYSTALLINE FIELD ON THE SPIN AVERAGE OF Sm^{3+} IN SAMARIUM INTERMETALLICS. Malik, S. K.; Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). pp 567-72 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. III. Bombay; Dept. of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.3).

Effects of a crystalline field on the spin average and the crossover temperature (at which sign reversal of spin average occurs) of Sm^{3+} in $SmSn_3$ and $SmAl_2$ were calculated. It was found that a strong crystalline field, which causes admixture of excited J states into the ground state of Sm^{3+}, can suppress entirely the crossover temperature. (D.L.C.)

Theoretical Physics

Refer also to abstracts 5875 and 5900.

5677 (CEA-N-1458-E) SPACE DISTRIBUTIONS FOR LARGE SPACINGS. Mehta, Madan Lal (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 11p. (In French). Dep. NTIS (U. S. Sales Only).

The behavior of $E_\beta(O,S)$, the probability of having no level in an interval of length S, for $S \gg 1$, is discussed. It is shown that $E_2(O,S)$ exp $((\pi^2/8)S^2)$ tends to zero as S tends to infinity. (France)

5678 (CERN-Trans-71-40) RESEARCH CONCERNING THE THEORY OF NONLINEAR RESONANCE AND STOCHASTICITY. Chirikov, B. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by A. T. Sanders (CERN, Geneva, Switzerland), from Report 267. 237p. Dep. NTIS (U. S. Sales Only).

The many-dimensional nonlinear oscillations of a conservative mechanical system are studied in a complete way, i.e., in an unlimited period of time and for arbitrary initial conditions. Models of the interaction of resonances of nonlinear oscillations are used in the analysis. (M.O.W.)

5679 (IFVE-SVM-70-54) STRUCTURE OF A WAVE-FUNCTION AND WAVE MODEL OF THE WORLD. Sokolov, S. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 37p. Dep. NTIS (U. S. Sales Only).

A mechanism of irreversible changes of wave functions was studied and wave structures were considered. The usual nonrelativistic quantum mechanics of many-body systems was used. Wave mechanics was built-up anew from a purely wave point of view on the bases of notions defined through the wave functions, and the difference of the new picture from the usual one is discussed. (W.D.M.)

5680 (ITEF-840) CALCULATION OF THE HIGHER HARMONICS IN THE METHOD OF HYPERSPHERICAL FUNCTIONS. Simonov, Yu. A.; Sadovoi, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method of constructing the higher harmonics within the framework of the formalism of hyperspherical functions (the K-harmonics) proposed earlier (Yad. Fiz., 7: 1210(1968)) for the solution of the problem of many bodies has been developed. The method permits the harmonic polynomials of arbitrary degree K to be obtained which satisfy the Pauli principle having defined values of the total orbital moment, spin, and mass spin and also projections of them. The expression for the matrix element as a function of single and double element operators is written in simple form convenient for calculations and similar with respect to form to the corresponding expressions of the usual model of shells. (JPRS)

5681 (JINR-P-4-5895) THEORY OF BOUND STATES IN SYSTEMS WITH NON-CONSERVING NUMBER OF QUASI-PARTICLES. Tosic, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of bound states in systems, in which the Hamiltonian does not commute with the operator of total occupation number, was investigated. The basic relations for the bound states in the linear approximation over the parameter Θ_0 being the ratio of excitation band width and excitation energy of an isolated molecule are obtained. It is shown that the further development of the theory in series of Θ_0 does not bear the essential difficulties. It is concluded that the nonconserving of quasi particles leads to decreasing of the gap between the free and bound states. (auth)

5682 (ORNL-4661) MATHEMATICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1970. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 191p. Dep. NTIS.

Most of this report is devoted to summaries of the activities of two departments (Computing Applications and Statistics) in their support of other ORNL divisions and in services to other Union Carbide Nuclear Division programs in Oak Ridge. Also briefly summarized are activities in mathematical research, systems programming, and computer services. Statistical seminars, professional activities, publications, and lectures and papers of the Division are listed. (L.M.T.)

5683 MOTION OF A CHARGED PARTICLE IN A STRONG MAGNETIC FIELD. Bernstein, Ira B. (Yale Univ., New Haven). Advan. Plasma Phys.; 4: 311-33(1971).

The reduced description in terms of drifts and adiabatic invariants of the motion of a charged particle in a strong magnetic field is derived. The demonstration employs systematically two time scales and an iteration scheme for each quasi periodicity. This leads to a particularly expeditious derivation, as well as the details of the rapid oscillations at each stage. Moreover, the motivation of each part is clear, as is the relation to simple problems in dynamics. The small parameters, the existence of which underlines the method, are displayed explicitly. (auth)

5684 QUANTUM THEORY AND BEYOND. ESSAYS AND DISCUSSIONS ARISING FROM A COLLOQUIUM. Bastin, T. (ed.). Cambridge, Eng.; Cambridge University Press (1971). 345p. £5.00.

This book contains the edited papers presented at a small informal colloquium held in Cambridge in 1968 to discuss the need for fundamental revision in quantum theory. A principal aim was to pinpoint the sources of difficulty in current ideas. Indications of the trends emerging from discussions are suggested in editorial introductions. The discussions held are presented under the headings: the conceptual problem of quantum theory from the experimentalist's point of view; Niels Bohr and complementarity, the place of the classical language; the measurement problem; new directions within quantum theory; what does the quantum theoretical formalism really tell us; a fresh start; and philosophical papers. (UK)

5685 COHERENT STATES AND THE INVARIANCE GROUP OF A CHARGED PARTICLE IN A UNIFORM MAGNETIC FIELD. Tam, W. G. (Univ. Laval, Quebec). Physica; 54: No. 4, 557-72(30 Sep 1971).

The coherent states are constructed for an arbitrary gauge. The transformation properties of the coherent states under the invariance group of the hamiltonian are also discussed. (auth)

5686 METHOD FOR EVALUATING THE STANDARD DEVIATIONS IN POINT RECORDED FUNCTIONS. Aramu, F.; Maxia, V.; Murgia, M. (Univ., Cagliari, Italy). Nucl. Instrum. Methods; 97: No. 1, 91-4(1971).

The question of evaluating the standard error when a variable quantity is measured by points is investigated. The case in which the points available are few, namely ten or more, is considered. By using a generalized Γ distribution which accounts for the probability that some linear combinations of square fluctuations lie in a given interval, the standard error for each measured point is determined. Taking into account the errors computed by a Monte Carlo procedure, an example is made which proves that the equations found here hold statistically, that is when employed in a large number of cases. (auth)

5687 RADIATION EFFECTS PRODUCED BY MODULATED ELECTRONS. Lipkin, H. J. (National Accelerator Lab., Batavia, Ill. Argonne National Lab., Ill.); Peshkin, M. Appl. Phys. Lett.; 19: No. 9, 313-15(1 Nov 1971).

In the experiment of Schwarz and Hora, modulated electrons can radiate substantially more light than unmodulated electrons only if the modulated electron wave function contains many plane-wave components. The radiated light must be coherent if it is emitted from a one-electron state or collectively from a product of modulated one-electron states. These conclusions are independent of the mechanisms of excitation and radiation. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

5688 COMPTON SCATTERING OF 3.5 GeV POLARIZED PHOTONS ON PROTONS. Buschhorn, G.; Criegee, L.; Franke, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett.; 37B: No. 2, 211-12(15 Nov 1971).

Elastic scattering of linearly polarized photons on protons was measured between 3.2 and 3.7 GeV for four-momentum transfers ranging from -0.1 to -0.7 $(GeV/c)^2$. The observed cross section asymmetry in this range is consistent with zero within ±0.05. (auth)

5689 PROTON COMPTON SCATTERING BETWEEN 2.2 AND 7 GeV. Buschhorn, G.; Criegee, L.; Franke, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett.; 37B: No. 2, 207-10(15 Nov 1971).

Proton Compton scattering was measured in a coincidence experiment at photon energies between 2.2 and 7 GeV and four-momentum transfers t between -0.06 and -0.85 $(GeV/c)^2$. For $|t| \leq 0.4$ $(GeV/c)^2$ fits of the form $d\sigma/dt = (A \cdot \exp(Bt))$ yield forward cross sections A in good agreement with the values calculated from the total hadronic γp cross section via the optical theorem and the forward dispersion relation. The slopes B do not show a significant energy dependence, the mean value being 5.7 ± 0.4 $(GeV/c)^{-2}$. The cross section is substantially larger than predicted by the vector-meson dominance model. (auth)

5690 SURVEY OF LARGE ZENITH ANGLE MUON DATA AT HIGH ENERGIES. Flint, R. W.; Nash, W. F. (Univ. of Nottingham, Eng.). Nucl Phys.; B33: No. 2, 632-42(1971).

A survey is presented of muon-spectrum charge-ratio measurements made with large zenith angle sea level spectrometers and underground telescopes, with particular reference to results from the Nottingham spectrometer. Production of the sea level muons via long-lived secondary particles is found to explain adequately the majority of the results described. (auth)

5691 COMPILATION OF COUPLING CONSTANTS AND LOW-ENERGY PARAMETERS. Ebel, G. (Univ., Karlsruhe, Ger.); Muellensiefen, A.; Pilkuhn, H.; (and others). Nucl. Phys.; B33: No. 2, 317-78).

A compilation of coupling constants and low-energy parameters for strong, electromagnetic, and weak interactions is presented. SU(3) predictions are also given. (L.B.S.)

5692 EXCITATION OF THE Δ(1236) RESONANCE ON BOUND STATE NEUTRONS. Bleckwenn, J. (Deutsches Elektronen-Synchrotron, Hamburg); Klein, H.; Moritz, J.; Schmidt, K. H.; Wegener, D. Nucl. Phys.; B33: No. 2, 475-84(1971).

The cross sections for inelastic electron-deuteron scattering were measured for invariant masses $W \leq 1.4$ GeV of the final hadronic state and momentum transfers of $0.1(GeV/c)^2 < q^2 < 0.5$ $(GeV/c)^2$. The cross section for inelastic electron-neutron scattering was obtained by subtracting the contribution of electron-proton scattering. The cross sections for inelastic electron-neutron and electron-proton scattering are shown to be equal. (auth)

5693 PRECISION MEASUREMENT OF THE MAGNETIC MOMENT OF THE MUON. Rothberg, J. E. (Univ. of Washington, Seattle). pp 327-34 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The ratio of muon to proton magnetic moment (μ_μ/μ_p) was measured to high precision in three chemical environments; the agreement shows that the "Ruderman correction" is not applicable. The result is $\mu_\mu/\mu_p = 3.183347(9)$ (2.8 ppM); in terms of the muon mass, this implies $m_\mu/m_e = 206.7683(6)$. (auth)

5694 PHOTOPRODUCTION OF PHI MESONS WITH LINEARLY POLARIZED PHOTONS. Sandler, Bernard. Ithaca, N. Y.; Cornell Univ. (1971). 140p. University Microfilms Order No. 71-24,521.

Thesis.

The asymmetry parameter $\Sigma = (\sigma_{||} - \sigma_\perp/\sigma_{||} + \sigma_\perp)$ in the reaction $\vec{\gamma} + A \rightarrow A + \phi \rightarrow K^+K^-$ is measured at 5.6 GeV, using carbon and hydrogen targets. A linearly polarized photon beam is produced by coherent bremsstrahlung from 9.7-GeV electrons incident on a diamond crystal. The two final state K-mesons from forward produced ϕ-mesons are detected in a pair spectrometer sensitive to symmetric decays of the ϕ-meson with a narrow horizontal aperture for the azimuth of the pair. The asymmetry is measured by rotating the plane of polarization of the photons 90 degrees relative to the detection system of the K^+K^- pair. The photon spectrum is measured with an electron pair spectrometer. The spectrum data are fit to a theoretical model with allowances made for collimation and resolution, yielding the beam polarization. This is averaged over the energy acceptance of the K-pair spectrometer to give an average polarization of 0.32 ± 0.015. The pair spectrometer is a fixed system of three dipole magnets aligned along the beam. Symmetric pairs of counters define the pair trajectories. A freon threshold counter vetoes pi-mesons with an efficiency better than 99 percent. Optical spark chambers are used to reconstruct the orbits of the K-meson pairs giving a mass resolution for the ϕ meson of ±2 MeV. The mass distributions from the reconstructed data are fit by a Breit–Wigner resonance and background term yielding cross sections $(d\sigma/dt)_{\theta=0}$. These are 158 ± 16 μbarns GeV^{-2} for carbon and 1.77 ± 0.5 μbarns GeV^{-2} for hydrogen which are consistent with other measurements. The asymmetry results are as follows: $\Sigma_{carbon} = 1.02 \pm 0.07$ and $\Sigma_{hydrogen} = 0.58 \pm 0.19$. The carbon asymmetry is consistent with a purely diffractive production. The asymmetry for hydrogen indicates a substantial nondiffractive component, which may be expressed as $(\sigma_\perp/\sigma_{||}) = 0.27 \pm 0.13$. (Diss. Abstr. Int., B)

5695 PHOTOPRODUCTION OF ETA MESONS FROM DEUTERIUM AT 0 AND 180° WITH PHOTON ENERGY FROM 725 TO 1225 MeV. Yellin, Steven Joseph. Pasadena, Calif.; California Inst. of Tech. (1971). 194p. University Microfilms Order No. 71-26,133.

Thesis.

In an experiment conducted at the Caltech 1.5-GeV electron synchrotron, the cross section for photoproduction of eta mesons from deuterium was measured. The measurement was performed by detecting and measuring the energies of both photons from the $\eta \rightarrow 2\gamma$ decay mode using two totally absorbing lead glass Cherenkov counters. These counters were placed symmetrically about the photon beam line in order to best detect eta mesons photoproduced along the beam line. By varying the placement of the Cherenkov counters and by varying the synchrotron end-point energy, one could obtain information on the forward and backward cross section for photoproduction over an energy range from about 725 to about 1225 MeV. Within the framework of the impulse approximation, the results were expressed as a sum of the differential cross section for eta photoproduction from protons plus that from neutrons. The unfolding of the cross section was performed by finding the function that was the smoothest (using a well-defined measure of smoothness) function that fits the data to within a given degree of accuracy (as measured by χ^2). The results show that for photon energy below 950 MeV, the cross section for photoproduction from neutrons is about equal in the forward and backward directions, and is about the same as the cross section for photoproduction from protons. Above 950 MeV, a significant angular asymmetry is seen, and the neutron cross section shows signs of reaching a minimum, then rising. These results are interpreted in terms of contributing isobars. (Diss. Abstr. Int., B)

5696 MEASUREMENT OF MUON PAIR ELECTROPRODUCTION. Earles, David Robb. Boston: Northeastern Univ. (1969). 186p. University Microfilms Order No. 71-25,757.

Thesis.

An experiment is described which tests quantum electrodynamics (QED) for the process $e^- + C \rightarrow e^- + C + \mu^+ + \mu^-$. The experiment measured the angles and energies of muon pairs produced in carbon by 4.9 GeV electron beam. The polar angle of each member of the muon pair was detected in nine intervals between 4.3 and 11.0°. The relative azimuthal angle of the two members of the pair was detected in seven intervals between 138 and 180°. The energy of each member of the pair was detected in two intervals between 2135 and 2688 MeV. The scattered electron was not detected. The data, after suitable corrections, were compared with the sum of QED predictions and the predictions of a phenomenological model describing ρ° production with $\rho^\circ \rightarrow \mu^+ + \mu^-$ decays. When interference between "time-like" QED amplitudes and the $\rho^\circ \rightarrow \mu^+ + \mu^-$ amplitude is neglected, fits of theory to the data result in a negative slope in the predictions of the "spacelike" QED amplitudes. This slope differs from zero by 2.6 standard deviations. A value of $(1.05 \pm 0.24) \times 10^{-4}$ is obtained for the $\rho^\circ \rightarrow \mu^+ + \mu^-$ branching ratio. A model

for the interference terms is included and additional fits of theory to the data are performed at various values of ϕ, the phase angle between the QED amplitudes and the $\rho^0 \rightarrow \mu^+ + \mu^-$ amplitude. For $\phi = 30 \pm 10°$ a value of the $\rho^0 \rightarrow \mu^+ + \mu^-$ branching ratio is obtained which is consistent with previous work, a slope in the predictions of the "spacelike" QED amplitudes is obtained which is consistent with zero, and the chi-squared probability is near a minimum. (Diss. Abstr. Int., B)

5697 PHOTOPRODUCTION OF ETA MESONS FROM HYDROGEN AT 0^0 AND 180^0 FOR ENERGIES BETWEEN 0.7 AND 1.1 GeV. McNeely, William Atwood Jr. Pasadena, Calif.; California Inst. of Tech. (1971). 182p. University Microfilms Order No. 71-27,106.

Thesis.

Using the Caltech 1.5-GeV electron synchrotron, the cross section for $\gamma p \rightarrow p\eta(\eta \rightarrow \gamma\gamma)$ at 0° and 180° was measured in the energy range 0.7 to 1.1 GeV. Two totally-absorbing lead glass Cherenkov counters detected both photons from the decay $\eta \rightarrow \gamma\gamma$, while the recoil proton went undetected. Eta events produced a peak in the di-photon energy spectrum of the two counters. Approximately 100,000 eta events were identified using a background subtraction procedure. The energy of the incident photon was not well resolved experimentally, which made the cross section evaluation difficult. One method of evaluation localizes the incident photon energy artificially by forming appropriate linear combinations of the physical measurements. An alternate method parametrizes the cross section as a smooth function of energy and fits the physically measured yield of eta events. The two methods agree tolerably well. A significant departure from angular isotropy in the cross section is observed starting at about 0.8 GeV, with the backward cross section dominating the forward cross section. This result plus recent measurements of the recoil proton polarization is interpreted, in the framework of a simple resonance model. Tentative upper limits are set for the contributions of the states $P_{11}(1460)$ and $S_{11}(1710)$ to the amplitude for eta photoproduction. (Diss. Abstr. Int., B)

Weak

Refer also to abstract 5690.

5698 (CONF-690217-(Ch.2), pp 110-38) NEUTRINO EXPERIMENTS WITH AN ACCELERATOR. Kaftanov, V. S. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

The history and fundamental results of experimental studies of neutrino interactions are presented. (auth)

5699 COHERENT REGENERATION IN HYDROGEN FROM 3 TO 10 GeV/c. Buchanan, C. D. (Univ. of California, Los Angeles); Drickey, D. J.; Rudnick, F. D.; (and others). Phys. Lett.; 37B: No. 2, 213-16(15 Nov 1971).

The proper time distribution of coherent $\pi^+\pi^-$ decays from a 3- to 10-GeV/c K_1^0 beam incident on a one meter liquid hydrogen target was studied using a wire spark chamber spectrometer in the 3^0 neutral beam at SLAC. $|(f(0) - \bar{f}(0))/k| = 0.43 \pm 0.11$ mb, $\phi(f(0) - \bar{f}(0)) = -101° \pm 42°$ was found. (auth)

5700 PROTON POLARIZATION IN SIGMA PLUS NONLEPTONIC DECAY AND THE DELTA ISOSPIN EQUALS ONE HALF RULE. Dettmann, Edward Henry. Madison, Wis.; Univ. of Wisconsin (1971). 104p. University Microfilms Order No. 71-20,661.

Thesis.

Polarized Σ^+ hyperons were produced in the reaction $\pi^+p \rightarrow K^+\Sigma^+$ by pions with beam momentum 1.12 GeV/c in a liquid hydrogen target. The polarization of protons from the decay $\Sigma^+ \rightarrow p\pi^o$ was measured by observing proton scatters in a carbon plate spark chamber and was used to determine the decay parameters α_0 and ϕ_0. For the Σ^+ sample, the daughter proton angular distribution gave $\alpha_0\bar{P} = 0.59 \pm 0.04$. Decay parameters obtained for the final sample of 1335 useful proton scatters were $\alpha_0 = -0.98^{+0.05}_{-0.02}$ and $\phi_0 = 22° \pm 91°$, where $\tan\phi_0 = \beta_0/\gamma_0$. This value of α_0 together with the decay rate for $\Sigma^+ \rightarrow p\pi^o$ and corresponding data for $\Sigma^+ \rightarrow n\pi^+$ and $\Sigma^- \rightarrow n\pi^-$ were used to make a fit with 2 degrees of freedom to the $|\Delta\vec{I}| = \frac{1}{2}$ rule to obtain a χ^2 of 0.44. (Diss. Abstr. Int., B)

5701 MEASUREMENTS OF THE BRANCHING RATIO AND FORM OF INTERACTION FOR THE BETA DECAY OF THE LAMBDA HYPERON. Maloney, John Edward. College Park, Md.; Univ. of Maryland (1971). 98p. University Microfilms Order No. 71-25,277.

Thesis.

There were 287 lambda beta decays, $\Lambda \rightarrow p + e^- + \bar{\nu}_e$ observed in a sample of approximately 3×10^5 charged lambda decays produced by a K^- meson beam stopping in the BNL 30 inch hydrogen bubble chamber. The branching ratio obtained for the beta decay mode is $\Lambda \rightarrow p + e^- + \bar{\nu}_e$/All Λ decays = $(.82 \pm .08) \times 10^{-3}$. The absolute value of the ratio of the axial vector to vector coupling coefficients used in the baryon current to describe the beta decay interaction is $|g_1/f_1| = .65^{+.23}_{-.14}$ with the 95% confidence limits $.40 \leq |g_1/f_1| \leq 1.24$. These results are insensitive to the effects of weak magnetism. (Diss. Abstr. Int., B)

5702 AMPLITUDE OF K_2^0-MESON REGENERATION IN Cu AT 0.8 / 3.8 GeV/c. Balats, M. Ya.; Berezin, V. M.; Bishnevskii, M. E.; (and others). (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 3, 630-8(Sep 1971). (In Russian).

The amplitude of the K_2-meson regeneration in Cu at 0.8 to 3.8 GeV/c is measured using a magnetic spectrometer with spark chambers. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 4597, 5951, and 5962.

5703 (CONF-690217-(Ch.2), pp 138-53) COMPLETE EXPERIMENT AT ONE GeV ENERGY. Kazarinov, Yu. M. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Two sets of phase shifts now exist which give a uniquely good description of experimental data on NN-scattering in the 600 to 650 MeV range. Since experiments are conducted at these energies to determine the Wolfenstein parameters (A_{np} and D_{np}) and the polarization transfer parameters D^t_{np}, and the results of these experiments exclude one of the existing sets of phases, the 1-GeV energy region is a region close to the region for uniquely determining the scattering amplitude. Despite the considerable increase in the number of parameters to be determined at energies above the meson formation threshold because of the absence of unitarity of the S-matrix, it is proposed on the basis of experiments at 635 MeV that the number of complex phases at 1 GeV will not exceed 10. The moment z_{max} from which the single-meson approximation at 1 GeV is valid is evaluated, and it is shown that the total number of unknown parameters is 41. It is established that it is necessary to measure four quantities to determine the 41 parameters: differential cross section, polarization and two elements of the depolarization tensor or two elements of the polarization correlation tensor. Each of these quantities must be measured with good accuracy at $(2l_{max} + 1)$ points. Twenty parameters are determined from pp-scattering data in isotriplet and 21 parameters can be determined from np-scattering data in isosinglet. The simplest complete experiment is proposed which includes measuring the following quantities: total interaction cross section, differential elastic scattering cross section, polarization occurring in elastic scattering, depolarization (Wolfenstein parameter D), and the Wolfenstein parameter R. It is pointed out that in using a polarized target and a polarized beam, the measurement of the polarization correlation C_{nn} should be preferred to measurement of any of the Wolfenstein parameters. Measurements already completed are analyzed and the experimental setup necessary to conduct a unique phase analysis is briefly discussed. (auth)

5704 (CONF-690217-(Ch.2), pp 198-218) POLARIZED PROTON TARGET AS A POLARIZER OF NEUTRONS. Shapiro, F. L. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

A description of a method developed at Dubna for polarizing neutrons with energy below 10^8 eV is given in a lecture. The principle of the method is that as neutrons pass through a target of polarized protons, the neutron beam is polarized due to the difference in the cross sections for triplet and singlet scattering. Several experimental results obtained using the method described are given as an example. (auth)

5705 (JINR-E2-6042) VIRTUAL EXCITATION OF NUCLEON ISOBARS IN NUCLEI AND QUASI-ELASTIC "KNOCKING-OUT" OF ISOBARS AT HIGH ENERGIES. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 8p. Dep. NTIS (U. S. Sales Only).

The isobar production in the hadron-nucleus collisions at high energies is proposed as a possible experimental test of the virtual excitation of isobars in nuclei. The qualitative features of the quasielastic "knocking-out" of isobars from nuclei are discussed. (auth)

5706 (LYCEN-7131) D(p,d*)p CROSS SECTION FROM THE D(p,pn)p REACTION. Burq, J. P.; Cabrillat, J. C.; Chemarin, M.; Ille, B.; Nicolai, G. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 14p. Dep. NTIS (U. S. Sales Only).

The systematic study of the reaction p + d → p + n + p was carried out in such a way that a neutron-proton final state interaction was observed predominantly. The 27.5-MeV incident deuterons or 13.5-MeV incident protons were used. The center of mass energy was approximately the same in both cases. The angular distribution of the d* production was measured. (France)

5707 ODD/EVEN RATIO FOR PIONIC ANNIHILATION OF ANTIPROTONS ON NEUTRONS IN FLIGHT. Aitchison, J. L. (Univ. of Melbourne, Parkville, Australia); Caro, D. E.; Gold, E.; (and others). Lett. Nuovo Cim.; 2: No. 19, 1009-10(6 Nov 1971).

A sample of 11,018 three-prong events from a bubble chamber experiment on $\bar{p}$ interactions in deuterium at 0 to 1 GeV/c was kinematically analyzed for the reactions $\bar{p}d \rightarrow \pi^+\pi^-\pi^-$ (p_s) and $\bar{p}d \rightarrow \pi^+\pi^-\pi^-\pi^0$ (p_s). It was found that even-pion annihilations predominate over odd-pion annihilations for $\bar{p}n$ interactions in flight, indicating a behavior which is in contradiction with π direct-channel resonance. (L.B.S.)

5708 A(Σ) PRODUCTION IN $\bar{p}d$ COLLISIONS BELOW $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ THRESHOLD AND POSSIBLE STUDY OF $\bar{Y}N$ ANNIHILATION. Camerini, U.; Cline, D.; Seghal, N. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nucl. Phys.; B33: No. 2, 505-11(1971).

The process $\bar{p}d \rightarrow \Lambda$ + (missing mass) was observed for antiproton momenta of 1.25, 1.31, 1.46 and 1.67 GeV/c. The Λ is observed to be predominantly produced backwards in the $\bar{p}d$ center of mass and a striking peak is observed in the missing mass spectrum near $\bar{\Lambda}N$ threshold. It is speculated that a kinematic origin of the peak as the result of $\bar{\Lambda}\Lambda N$ intermediate states with a resultant ΛN threshold singularity would be possible if off mass shell deuteron corrections are assumed to be important. A resonance interpretation of the missing structure cannot be completely ruled out as a possibility. In this case the data would suggest the existence of a new K* with mass 2060 ± 20 meV and width Γ = 120 ± 50 MeV. (auth)

5709 CHACALTAYA EMULSION CHAMBER EXPERIMENT. Lattes, Cesar M. G. (Univ. Estadual, Campinas, Brazil); Mantovani, Marta S. M.; Santos, Claudio; (and others). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 1-125(1971).

The results obtained by the collaboration experiment of the Brazil and Japan Emulsion Group over a period of nearly ten years since 1962 are reported. It is divided into five parts. I. Introduction gives a short description of the emulsion chambers exposed at Mt. Chacaltaya Laboratory (5200 m), Bolivia, ranging from Câmara No. 1 of 0.4 m^2 up to Câmara No. 15 of 44.2 m^2, with a brief historical review of the collaboration experiment. Main part of the present results are obtained with Câmara No. 12 (6 m^2) and No. 13 (9.8 m^2), both of which have the producer layer for nuclear interactions in the chamber itself. II. Morphological Studies on Cosmic-ray Components give the results on frequency, energy spectrum and zenith angle distribution of the electromagnetic and the nuclear-active components at Chacaltaya. The vertical flux for the electromagnetic component is $(2{,}66 \cdot 10^{-9}/\text{cm}^2\ \text{sec sterad}) \cdot (E/10^{12}\ \text{eV})^{-\beta}$ with $\beta = 2.07 \pm 0.10$, covering energy region of $2 \cdot 10^{11}$ eV ~ $5 \cdot 10^{13}$ eV. Ratio of a flux value of the electromagnetic component to that of the nuclear-active component of the same visible energy is ~0.56, constant over the concerned energy region. III. Fire-ball Studies on C-jets give detailed analysis on 85 events of local nuclear interactions with $\Sigma E_r \geq 3$ TeV occurred in the producer layer. High energy γ-rays produced in the interaction are described in the integral form as $N_r \exp(-N_r E_r/\Sigma E_r)$ with $N_r = 8 \pm 1$. All of the results on energy spectrum, angular distribution, p_T distribution and $p_T - \theta_r$ correlation show that those γ-rays are products of an isotropic intermediate state (a fire-ball) with momentum distribution, $N_r \exp(-p_r^*/p_0)(p_r^*/p_0^2)dp_r^*$ with $N_r = 8 \pm 1$, $p_0 = 82 \pm 15$ MeV in its rest system. A fire-ball analysis is made on individual 75 C-jets with the observed γ-ray multiplicity equal to or greater than 4. Seventy-one events are found to show emission of a fire-ball. Their experimental mass spectrum has a peak at $M_r \sim 1.2$ GeV, giving the average value as $\langle M_r \rangle = 1.28 \pm 0.35$ GeV where M_r is a part of the rest energy liberated into γ-rays. IV. Atmospheric Interactions is concerned with analysis on 41 γ-ray families which are selected by the imposed criteria as representing directly the parent atmospheric interactions. The events are divided into two groups according to their value of a sum of transverse momenta of γ-rays as: (A) $\Sigma p_{T_r} \lesssim 2.5$ GeV/c and (B) $\Sigma p_{T_r} > 2.5$ GeV/c. Fire-ball analysis on 28 events of the group (A) shows that they are emissions of a fire-ball of identical properties with that found in the C-jets. Whereas, 13 events of the group (B) are found to exhibit emission of a larger fire-ball, named as "super heavy quantum (SH quantum)." The experimental data give its mass as $M_r = 8 \pm 2$ GeV and isotropic emission of γ-rays with average multiplicity $\langle N_r \rangle = 30 \pm 8$. Its total rest energy will be 20 ~ 25 GeV. The momentum distribution of γ-rays from the SH-quantum is not of a simple exponential form but has a less steep tail on the higher momentum regions. V. Conclusion gives a summary of the results and comparisons with other experiments. Emission of a small fire-ball with $M_r = 1.31 \pm 0.28$ GeV (average over 99 events) is confirmed in multiple production process over a wide energy region starting the accelerator region of ~10 GeV up to cosmic-ray region of $\Sigma E_r \sim 100$ TeV. Its total rest energy is estimated to be 2.2 ~ 2.6 GeV. This is identified as "H-quantum" proposed by Hasegawa. Re-analysis of the Bristol-Bombay experiment of a balloon emulsion chamber confirmed the existence of the H- and SH-quanta. Fire-ball analysis on the Texas Lone Star of the Bristol group shows a fire-ball of still larger mass, its M_r being about 78 ± 10 GeV. A large air shower event called Andromeda with $\Sigma E_r \sim 3 \cdot 10^{16}$ eV suggests the existence of a large fire-ball of the same property. Thus, as a conclusion, there are the three types of a fire-ball with its total rest energy expressed as $M_n = m_0 a^n$ with $m_0 \sim 230$ MeV, a ~10 and n = 1, 2, and 3. Because of this particular nature, all of such fire-balls are considered as new states of matter connecting directly with the stratum of the sub-elementary particles. (auth)

5710 NEW HORIZON OF ACCELERATOR PHYSICS. Hasegawa, Shun-ichi (Waseda Univ., Tokyo); Nanjo, Hirotada; Ogata, Takeshi; (and others). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 126-79(1971).

The multiple meson production in the accelerator region was studied on the basis of information obtained from high-energy nuclear interactions in cosmic ray research. Particular attention is focused on the H-quantum hypothesis. The experimental results obtained from measurement of 22.6- and 24-GeV/c protons with free and quasi-free nucleons in the nucleus in nuclear emulsion are presented. An analysis of the angular distribution showed that the multiple meson production takes place through production of a single fireball, which moves forward or backward in the center-of-mass system. The detailed nature of the fireball was studied by analysis of hydrogen bubble chamber film exposed to 10 GeV/c negative pions in order to confirm results obtained in the nuclear emulsion analysis. The results of both studies are summarized and compared with other experiments. (L.B.S.)

5711 PROPAGATION OF COSMIC RAYS IN THE ATMOSPHERE AND MODELS OF MULTIPLE MESON PRODUCTION. Osawa, Akinori (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 180-213(1971).

The propagation of the primary and secondary cosmic-rays in the atmosphere is calculated theoretically, and the propriety of models of multiple meson production is examined through the comparison of the calculated results with experimental data. The mechanism of multiple meson production is formulated according to three main models of the phenomena (two-fire-ball model, H-quantum model and excited baryon model) which are under discussion at present, without losing their characteristic properties. The diffusion equations for various cosmic-ray components are solved and general solutions are given. The calculated results are compared with the experimental data of electromagnetic and nuclear-active components at Mt. Norikura by Japanese emulsion chamber group and at Mt. Chacaltaya by Japan-Brazil Emulsion Chamber Collaboration. μ-meson component is compared with the experimental data at Kolar Gold Field by Japan-India Collaboration. Special attention is paid to the energy dependence of the relative flux ratio between nuclear-active and electromagnetic components, $I_{Pb}(E)/I_\gamma(E)$, because the error and ambiguity inherent to the absolute measurement of cosmic-ray components can be eliminated. It is concluded through these comparisons that H-quantum model gives the best agreement with experimental data among them, and that two-fire-ball model is rejected due to its energy dependence of $I_{Pb}(E)/I_\gamma(E)$. (auth)

5712 STUDY OF THE REACTIONS $\bar{p}p \rightarrow \pi^+\pi^-$ AND $\bar{p}p \rightarrow k^+k^-$ FROM 0.7 TO 2.4 GeV/c. Nicholson, Howard White Jr. Pasadena, Calif.; California Inst. of Tech. (1971). 203p. University Microfilms Order No. 71-21,898.

Thesis.

Differential cross sections for the annihilation reactions $\bar{p}p \rightarrow \pi^+\pi^-$ and $\bar{p}p \rightarrow k^+k^-$ were measured in the angular region $0.65 \lesssim |\cos\theta_{cm}| \lesssim 1.0$ at 14 incident antiproton momenta at intervals of approximately .1 GeV/c between 0.7 and 2.4 GeV/c. In the angular region $.90 \leq |\cos\theta_{cm}| \leq 1.00$ the forward going particle traversed a magnet and the differential cross sections for its charge sign could be measured. In the remaining angular region only the folded cross sections $[d\sigma/d\Omega(\theta_{cm}) + d\sigma/d\Omega(\pi - \theta_{cm})]$ could be obtained.

The data which, when binned in cos θ_{cm} bins which varied between .02 and .05 gave differential cross sections with statistical errors between 10 and 30%, were obtained in a counter experiment at the Alternating Gradient Synchrotron of the Brookhaven National Laboratory during the fall and winter of 1968. At extreme angles the two pion annihilations show considerable structure, while the two kaon annihilations fall approximately exponentially. Between 0.7 and 1.34 GeV/c the positive meson has a larger cross section for moving in the $\bar{p}$ beam direction; between 1.34 and 2.40 GeV/c the situation reverses. The data from this experiment have been combined with the data from a previous Caltech experiment to give complete folded angular distributions and total annihilation cross sections at 12 momenta. The folded pion cross sections show dramatic energy dependence changing from a single dipped distribution at low momenta to a doubled dipped distribution at the higher momenta. The folded two kaon cross sections also show considerable energy dependence but its distribution remains predominately single dipped over the momentum range of this experiment. The folded two pion annihilation data have been fit by a simple resonance model with two resonances. The two-kaon data were interpreted in terms of particle exchanges. (Diss. Abstr. Int. B)

5713 MEASUREMENT OF n–p CHARGE EXCHANGE DIFFERENTIAL CROSS SECTIONS FROM 2 TO 12 GeV/c. Miller, Edward Lawrence. Columbus, Ohio; Ohio State Univ. (1971). 103p. University Microfilms Order No. 71-22,509.

Thesis.

The execution is described and the results presented for an experiment which measured n-p charge exchange differential cross sections with high statistical precision for incident momenta from 2 to 12 GeV/c, and four-momentum transfers from 0.002 to 0.90 $(GeV/c)^2$. The two-arm experiment was performed in a continuous energy neutron beam at the Argonne ZGS in the winter of 1969 to 1970; the proton arm was a wire chamber magnetic spectrometer and the neutron arm contained banks of thick scintillation counters. A 3-constraint kinematic fit was performed for each of 1.65×10^6 triggers, allowing selection of $.18 \times 10^6$ charge exchange events. Absolute normalization of the data to ±20% was obtained from a measurement of n-p forward elastic scattering over the same energy range. The results are compared with predictions from the "strong cut Reggeized absorption model" (SCRAM). (Diss. Abstr. Int., B)

5714 MAGNETIC MOMENT OF THE Λ HYPERON. Alley, Paul Wayne. Seattle; Univ. of Washington (1971). 237p. University Microfilms Order No. 71-24,017.

Thesis.

A measurement of the Λ hyperon magnetic moment was extracted from data obtained in an experiment designed to measure the Σ^+ hyperon magnetic moment. A total of 3210 Λ events were obtained from the reaction $\pi^+ + n \rightarrow K^+ + \Lambda$ at a π^+ momentum of 1280 MeV/c. The target neutrons were bound in carbon. The parity-violating decay of the Λ into $p + \pi^-$ was used to detect the procession of the Λ spin in a large, pulsed magnetic field. The final state K^+ and the Λ decay products were detected in a small spark chamber in the bore of the solenoidal magnet. The 1746 field-on events yielded the value for the magnetic moment of $\mu_\Lambda = -1.29 \pm 0.82$ nuclear magnetons. (Diss. Abstr. Int., B)

5715 EMISSION OF HAMMER TRACKS IN 20-GeV/c PROTONS AND 3.5-GeV/c π^--MESON INTERACTIONS WITH HEAVY NUCLEI OF EMULSIONS. Deka, G. C. (Cotton Coll., Gauhati, India); Deka, K. C.; Talukdar, G. N.; Bhuyan, H. R. Indian J. Pure Appl. Phys.; 6: No. 9, 479-81(Sep 1968).

Six hundred and eighty-one "hammer" tracks were observed in interactions of 20-GeV/c protons and 3.5-GeV/c π^--mesons in two nuclear emulsion stacks. The energy spectra and the angular distributions of the fragments are studied, and the results compared with the predictions of the "evaporation" theory. The values of the parameters found suitable for interpreting the experimental observations are: T = 11 MeV, V = 3 MeV, and β = 0.015 for the proton interactions; and T = 10 MeV, V = 5 MeV, and β = 0.010 for the pion interactions. (auth)

5716 SCATTERING OF 600 MeV PROTONS FROM THE LIGHTEST NUCLEI. Boschitz, E. T. (Univ., Karlsruhe, Ger.). pp 385-92 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The results of measurements of differential cross sections and polarizations for p–^{4}He, p–^{3}He, p–D, and p-p scattering at 600 MeV are interpreted using the multiple scattering theories of Watson and Glauber. (L.B.S.)

5717 π PRODUCTION BY 730-MV PROTONS. Nagle, D. E. (Los Alamos Scientific Lab., N. Mex.). pp 416-22 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Measurements of proton production of pions performed primarily to obtain data for design of secondary beams at the Berkeley 184" cyclotron are reported. Differential cross sections were measured at ten angles in the interval 15 to 150°, at ten energies from 45 to 550 MeV, for H, C, Al, Fe, Cu, Ta, W, Ti, Ag, Au, and Pb. Some data are presented. (L.B.S.)

5718 COSMIC-RAY STUDY OF PROPERTIES OF NUCLEAR INTERACTIONS IN THE 10 TO 600 GeV ENERGY RANGE USING EMULSIONS, SPARK CHAMBERS, AND AN IONIZATION SPECTROMETER. Stafford, Edward Grigsby Baton Rouge, La.; Louisiana State Univ. and Agricultural and Mechanical Coll. (1971). 197p. University Microfilms Order No. 71-29,393.

Thesis.

A balloon borne apparatus consisting of an emulsion target, two spark chambers, and an ionization spectrometer was used to study properties of nuclear interactions of cosmic rays in the energy range 10 to 600 GeV. The spark chambers were used to locate in the emulsions the tracks of some of the primaries which had triggered the apparatus. A sample of 118 primaries with Z > 1 which did not interact in the emulsion target was used to calibrate the positions of the emulsions with respect to the spark chambers. For these primaries, after the calibration, the standard deviations of errors in location coordinates and in projected and dip angles were 0.2 mm and 0.2°, respectively. A total of 192 out of 193 Z > 1 primaries and 29 out of 43 Z = 1, target interacting primaries were located in the emulsions without significant ambiguity. All of the 63 Z = 1, noninteracting (in target) primaries with energies greater than 40 GeV were also located in the emulsions without any ambiguities. The ionization spectrometer, used to measure the energies (E_{sp}) of the primaries passing through the apparatus, was calibrated at accelerator energies. This calibration was extrapolated to higher energies using three-dimensional Monte Carlo calculations. The angular distributions of secondaries from primaries which interacted in the emulsions were measured. These measurements were used to calculate energy estimates which were compared with the E_{sp} values. This comparison indicated that for proton interactions the method (1.5 E_{ch}) based on the constancy of transverse momentum and inelasticity overestimates the energy by a factor of only 1.1 ± 0.2, whereas the method (E_{cast}) of Castagnoli overestimates the energy by a factor of 5 ± 2. The factors corresponding to fluctuations of individual estimates for 1.5 E_{ch} and E_{cast} are 2.3 ± 0.2 and 7 ± 2, respectively. The proton events were also analyzed for various groupings according to the values of E_{sp}, number (N_h) of black and gray tracks, and number (n_s) of secondary particles. For interactions of Z > 1 primaries, methods (E_p and E_α) based on the opening angle of fragments and 1.5 E_{ch} are in good agreement with the spectrometer determinations. It is found that, if the depth of the first interaction of each primary is known to within ±¼ interaction length, the spectrometer estimate is not sensitive to the other known characteristics of the first interaction such as number and angular distribution of charged secondary particles. The mean charged particle inelasticity was found to be about 0.5 ± 0.1 for proton interactions. For proton interactions with $N_h \leq 5$, $E^{¼}$ and ln E functions give better fits to the $\langle n_s \rangle$ vs. E data than the $E^{¼}$ function. An attempt was made to determine the proton-nucleon elastic cross section using the 63 Z = 1, noninteracting primaries, which had a mean energy of 83 GeV. These primaries did not interact in the emulsions with particle production. A total of 10 m of primary proton tracks was line-scanned for stars resulting from elastic scatterings on nucleons bound in emulsion nuclei. Two elastic-like scatters were found, but these can be shown to be random track-interaction coincidences, consistent with the number of proton recoils expected from neutron stars. No elastic scatters were found. A Monte Carlo analysis was used to calculate the probability of obtaining an observable proton associated with an elastic-like event in photographic emulsion. This analysis of the observation probability of an elastic scatter indicates that the proton-nucleon elastic cross section at 83 GeV is not greater than 3 mb with 95% probability. (Diss. Abstr. Int., B)

5719 MEASUREMENT OF THE ENERGY FRACTION TRANSFERED TO γ QUANTA IN INTERACTIONS OF COSMIC NEUTRONS WITH CARBON. Babayan, Kh. P.; Boyadzhyan, N. G.; Mamidzhanyan, E. A. (Erevan Physical Inst.). Yadern. Fiz.; 14: No. 3, 639-41(Sep 1971). (In Russian).

Results are presented on measurement of the partial inelasticity coefficient K_{π^0} in carbon for nucleons in the energy region $5(10)^{11}$ to $5(10)^{12}$ eV. A distribution is obtained for K_{π^0} and its mean value: $0.25 \pm 0.07 \leq \overline{K_{\pi^0}} \leq 0.31 \pm 0.06$. (auth)

Strong (Meson-Induced)

Refer also to abstract 5709.

5720 (ITEF-802) INVESTIGATION OF THE SYSTEMS $\pi^0\gamma$, $\eta^0\gamma$, $\pi^0\pi^0\gamma$, $\pi^0\pi^0$ IN THE REACTION $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ AT 2.9 GeV/c. Baldin, A. B.; Ergakov, V. A.; Trebukhovskii, Yu. V.; Shishov, N. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The reaction $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ was investigated using the 120-liter propane-xenon bubble chamber. The decay $\omega^0 \rightarrow \pi^0\gamma$ was observed. The evaluated ratio is $\omega^0 \rightarrow \pi^0\gamma/\omega^0 \rightarrow \pi^0\pi^+\pi^- = 0.081 \pm 0.020$. Branching ratios for $\omega^0 \rightarrow \rho^0\gamma/\omega^0 \rightarrow \pi^0\gamma < 0.40$ and $\omega^0 \rightarrow \pi^0\pi^0\gamma/\omega^0 \rightarrow \pi^0\gamma < 0.14$ were measured with 95% of confidence. Distribution in effective masses of $2\pi^0$-mesons produced together with $N^{*++}(1240)$ at $t_{\pi^+p} < 15\ \mu^2$ and $2\pi^0$-mesons mass distribution defined by effective and missing mass method are given. The results are compatible with existing broad enhancement in mass region 500 MeV $\leq M_{\pi^0\pi^0} \leq$ 900 MeV. (auth)

5721 (ITEF-835) DEVELOPMENT OF RESONANCES IN THE $p\pi^+\pi^-$-SYSTEM IN THE REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ AT 4.45 GeV/c. Beketov, G. V.; Zombkovskii, S. M.; Konovalov, B. S.; Kruchinin, S. P.; Selektor, Ya. M.; Shulyachenko, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

In a liquid-hydrogen bubble chamber $p\pi^+\pi^-$-effective mass distributions from the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 4.45 GeV/c were studied. The characteristics of ~1460 MeV and ~1690 MeV isobars were investigated. (auth)

5722 TOTAL CROSS-SECTION OF PROCESSES OF THE $\pi^-p \rightarrow$ NEUTRAL PARTICLES FOR INCIDENT MOMENTA RANGING FROM 250 TO 1800 MeV/c. Cheze, J. B.; Codreanu, N.; Hamel, J. L.; (and others) (CEN, Saclay, France). Lett. Nuovo Cim.; 2: No. 19, 997-1000(6 Nov 1971).

The total cross section of processes of the type $\pi^-p \rightarrow$ neutral particles was measured for incident momenta from 250 to 1800 MeV/c at 25 MeV/c steps, using anticoincidence counters set up around a hydrogen target. The data are presented. (L.B.S.)

5723 INTERACTIONS OF 290 MeV/c POSITIVE PIONS WITH DEUTERIUM. Norem, James H. (Rutgers--The State Univ., New Brunswick, N. J.). Nucl. Phys.; B33: No. 2, 512-24(1971).

The total cross section and the differential cross sections of the reactions $\pi^+d \rightarrow \pi^+d$, $\pi^+d \rightarrow \pi^+pn$, $\pi^+d \rightarrow \pi^0pp$, $\pi^+d \rightarrow \gamma pp$, and $\pi^+d \rightarrow pp$ were measured using 85,000 pictures of 290 MeV/c positive pions in the 38 cm Princeton-Pennsylvania bubble chamber. The elastic, inelastic and charge exchange scattering data are more complete than any previous data in this energy range. (auth)

5724 STUDY OF K^+d INTERACTIONS FROM 865 TO 1585 MeV/c. Hirata, A. A.; Goldhaber, G.; Seeger, V. H.; Trilling, G. H.; Wohl, C. G. (Univ. of California, Berkeley). Nucl. Phys.; B33: No. 2, 525-57(1971).

Experimental results on K^+d interactions from 865 to 1585 MeV/c incident beam momentum are presented. Measurements of several K^+d partial cross sections are reported and most of the others are calculated using relations derived from isospin conservation and data from other experiments. The most striking feature of the cross section data is the abrupt rise of the total single-pion-production cross section near 1000 MeV/c. Isospin-0 KN partial cross sections are extracted and a rapid increase of $\sigma_0(KN\pi)$ at the threshold is found for the quasi-two-body reaction $KN \rightarrow K^*N$. As in the case of the isospin-1 K^+N system, it appears that the structure around 1200 MeV/c in the total cross section for the isospin-0 K^+N system is well reconstructed by the sum of three smoothly varying channel cross sections $\sigma_0(KN)$, $\sigma_0(KN\pi)$, and $\sigma_0(KN\pi\pi)$. The reaction $KN \rightarrow K^*N$ near threshold is studied and it is found that the production and decay angular distributions can be interpreted in terms of t-channel phenomena, specifically a superposition of ω, ρ, and π exchange. As is true of the isospin-1 $K\Delta$ and K^*N final states, the isospin-0 K^*N state has a behavior near threshold which is not very different from its behavior at much higher energy. (auth)

5725 COHERENT PRODUCTION OF PIONS ON NUCLEI: DETERMINATION OF UNSTABLE BOSON--NUCLEON TOTAL CROSS SECTIONS. Bemporad, C. (CERN, Geneva); Beusch, W.; Melissinos, A. C.; (and others). Nucl. Phys.; B33: No. 2, 397-420(1971).

Measurements of the differential cross section and of the effective mass distribution of three- and five-pion coherent production on nuclei from Be to Pb are presented. The data are interpreted with an optical model and the total cross section of the unstable multipion system with nucleons is derived as a function of the effective mass. (auth)

5726 ($p\pi^+\pi^-$) MASS ENHANCEMENTS IN THE INTERACTIONS OF 8 GeV/c π^+, 16 GeV/c π^+, 16 GeV/c π^-, AND 10 GeV/c K^- WITH HYDROGEN. Boesebeck, K. (Technische Hochschule, Aachen); Graessler, H.; Kraus, G.; (and others). Nucl. Phys.; B33: No. 2, 445-63(1971).

Two enhancements are observed in the ($p\pi^+\pi^-$) mass spectrum at about 1460 MeV and about 1710 MeV in the reactions $\pi^-p \rightarrow (p\pi^+\pi^-)\pi^-$ at 16 GeV/c, $\pi^+p \rightarrow (p\pi^+\pi^-)\pi^+$ at 8 and 16 GeV/c and $K^-p \rightarrow (p\pi^+\pi^-)K^-$ at GeV/c, with production cross sections of approximately 30 μb. Mass and width values closely agree for all these reactions. Fits to the combined distributions give $M_0 = 1462 \pm 10$ MeV and $M_0 = 1711 \pm 10$ MeV, with widths of 60 ± 20 MeV and 57 ± 15 MeV, respectively. Neither enhancement is seen in charge exchange reactions. Their production cross section is almost constant, varying with the incident momentum as $\sigma = p_{Lab}^{-0.2}$. The differential cross section is exponential at small t'-values, $d\sigma/dt' \propto e^{-Qt'}$, with Q about 15 GeV^{-2} and about 6 GeV^{-2} for the first and the second enhancement, respectively. Both enhancements are interpreted as produced by a diffraction process. Evidence for the decay mode $\Delta^{++}(1236)\pi$ for the 1460 MeV enhancement is presented, and the possible existence of both $\Delta^{++}(1236)\pi$ and $N^{*0}(1460)\pi$ decay modes for the 1710 MeV enhancement is discussed. These results are compared with previous bubble chamber data and with the results of both phase-shift analyses of formation experiments and missing mass spectra of counter experiments. It is suggested that the diffraction enhancements at 1460 and 1710 MeV found in these production experiments may be different from the isobars found by phase shift analyses of formation experiments. It is pointed out that the effects observed in the ($p\pi\pi$) final state are only one of the contributions deriving from the different final states globally observed in the MM spectra of electronic experiments. (auth)

5727 SINGLE-PARTICLE DISTRIBUTIONS OF π MESONS PRODUCED IN K^-p INTERACTIONS AT 9 GeV/c. Foster, M.; Cole, J. A.; Kim, E.; Lee-Franzini, J.; (and others) (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 27; No. 19, 1312-16 (8 Nov 1971).

Distributions of transverse momentum squared and of longitudinal momentum in the laboratory, center-of-mass, and projectile frames are presented for pions produced in K^-p interactions at 9 GeV/c. Comparisons made with the corresponding distributions published by other laboratories for pion production in K^+p, π^+p, pp, and π^-p interactions indicate that in the proton fragmentation region the distributions for pions produced from K^-p interactions at 9 GeV/c have not yet reached a limiting behavior. (auth)

5728 RECOIL INELASTIC PION SPECTRA RESULTING FROM 2.15 TO 6.00 GeV/c PI-MINUS PROTON INTERACTIONS. Anthony, Robert Wynne. Ann Arbor, Mich.; Univ. of Michigan (1971). 211p. University Microfilms Order No. 71-23,690.

Thesis.

A large optical spark chamber recoil spectrometer was used to study charged inelastic pion scattering from π^-p interactions. Eleven pion beam momenta, 2.15 through 6.00 GeV/c, were analyzed using primarily an automatic scanning and programmed event recognition system. An independent, manual digitizing system assisted and spot checked the automatic system. The laboratory cross sections are presented for backward inelastic pion production for recoil pion momenta $P_{||}$ from elastic threshold down to 0.200 GeV/c and transverse momenta $P_\perp^2$ from 0.008 to 0.063 $(GeV/c)^2$. A Gaussian distribution $\exp(-26.0\ P_\perp^2)$ fits the transverse momentum dependence of the cross section in this range of $P_\perp^2$ to within the overall ±10% angular uncertainty. From 3.95 GeV/c beam momentum onward, the laboratory recoil momentum spectra appear to be beam energy independent to within the combined statistical, and ±6% energy-to-energy systematic uncertainties. A comparison with other 25 GeV/c data for the reaction shows relative agreement with the laboratory cross sections projected to $P_\perp^2 = 0$. Moreover, recoil inelastic pions from 19.2 GeV/c $pp \rightarrow \pi^+ +$ anything interactions are distributed similarly to the inelastic recoils. Various parameterizations of the recoil spectra at $P_\perp^2 = 0$ are possible. Three, which are mutually equivalent to the factorization $d^2\sigma/dMdU' \propto f(M)g(S)$ combined with asymptotic energy independence of the invariant cross section, are: the parameterization of Yang's hypothesis of limiting fragmentation $(HLF)E_\pi \cdot d^3\sigma/dP_{||}(dP_\perp^2)|_{lab} \propto (P_{||} - P_{||}(\infty))^{b''-1}$, where $P_{||}(\infty) = (M_\pi^2 - M_p^2)/2M_p$ is the infinite beam momentum elastic recoil threshold; the implied form of the factorization $d^2\sigma/dMdU' \propto M^{2b'-1}\ S^{-b}$, where M is the forward missing mass and S is the total center of mass energy squared; and finally the

form predicted by the parton model for leading particles having X near unity $f(S,X,Q^2=0) \propto (1-X)^{b''-1} \equiv (1-X)^{1-2\alpha}$, where X is $P_{||c.m.}/(\sqrt{S}/2)$. As the energy $S \to \infty$ these three parameterizations are shown to become equivalent with $b = b' = b'' = b''' =$ constant. Whenever the invariant cross section depends entirely on any combination of the four variables $P_{||lab}$, M^2/S, X, and U (the four-momentum transfer from the target proton to the recoil pion), the HLF is satisfied. Specifically, the baryon exchange contribution to the leading recoil pion cross section in the multi-Regge-model of Caneschi-Pignotti satisfies HLF with their assumption of the Pomeranchuk trajectory representing the forward missing mass vertex. (Diss. Abstr. Int., B)

5729 CHARGED SIGMA HYPERON PRODUCTION IN K^-D INTERACTIONS AT 4.925 GeV/c. DiBianca, Frank Anthony. Pittsburgh; Carnegie-Mellon Univ. (1971). 154p. University Microfilms Order No. 71-24,103.

Thesis.

The results of a study of charged sigma hyperon-multimeson final states produced in 4.925 GeV/c K^-d interactions are presented. The data were obtained from a 5 event/μb. exposure of the Brookhaven National Laboratory 80-inch bubble chamber. General features of the data are discussed (cross sections, angular distributions, Σ^- and Σ^+ lifetimes, etc.). The total and differential cross sections of the ten two-body reactions observed are presented. These data and those from experiments at other energies are used to determine Morrison's parameter, n, for strange meson and baryon exchanges. The measured spin density matrix elements for the vector mesons (ρ,ω,ϕ) indicate production via vector meson exchanges. $\Lambda(1520)\pi^-$ production is analyzed according to the Stodolsky-Sakurai development of the vector meson-photon analogy and found to be consistent with a pure M2 transition. In addition, the two-body cross sections from this and other experiments are compared with predictions of several independent quark models. A search for high mass Y* production is undertaken and several interesting results are obtained, such as evidence for $\Sigma\pi\pi$ and $\Sigma\rho$ decay modes of the $\Lambda(2350)$. Using the 74 ϕ decays in the event sample $\Sigma^-K^-K^+$, a high precision measurement of the ϕ mass and width were made. The results are $M_\phi = 1019.6 \pm 0.6$ MeV/c^2 and $\Gamma_\phi = 5.5^{+}_{-}{}^{?}_{?}$ MeV/c^2. Finally, events with visible spectator protons are used to study the s-channel cross section variation with center of mass energy in the 2.8 to 3.6 GeV region. Structure observed in the nonperipheral data is interpreted as evidence for the possible formation of a $\Sigma(\sim 3100)$ and a $\Sigma(\sim 3350)$. (Diss. Abstr. Int., B)

5730 TWO-BODY, CHARGED SIGMA PRODUCTION NEAR 1670 MeV. Kronenfeld, Jerrold Ernest. Durham, N. C.; Duke Univ. (1971). 118p. University Microfilms Order No. 71-24,192.

Thesis.

The reactions $K^- + p \to \pi^- + \Sigma^+$ and $K^- + p \to \pi^+ + \Sigma^-$ were investigated at total center of mass energies of 1668 and 1672 MeV. A total of 3643 $\pi^+\Sigma^-$ events and 1897 $\pi^-\Sigma^+$ events satisfying certain angle and length restrictions were found. Cross sections and angular distributions were measured for both reactions and polarization distributions for the $\pi^-\Sigma^+$ final state at the two energy settings. These distributions were fit to Legendre and first associated Legendre polynomial expansions $d\sigma/d\Omega = \lambda^2 \Sigma_{m=0}^{N} A_m P_m(\cos\theta)$ and $aP(d\sigma)/(d\Omega) = \hat{n}\lambda^2 \Sigma_{m=1}^{N} B_m P_m^1(\cos\theta^*)$ where λ is the center of mass wave length of the incident K^- beam divided by 2π, a, the asymmetry decay parameter for the Σ hyperon, $\hat{n}$, a unit vector normal to the production plane, A_m and B_m the energy dependent coefficients, and $P_m(\cos\theta^*)$ and $P_m^1(\cos\theta^*)$ the mth order Legendre and first associated Legendre polynomials (as functions of the center of mass scattering angle of the pion). The cross sections and most of the coefficients were found to agree very well with work previously done in this area. Large disagreement, however, was found in the A_1 and A_4 coefficients for the $\pi^+\Sigma^-$ final state. The source of the disagreement was investigated and discussed. (Diss. Abstr. Int., B)

5731 PIONIC FINAL STATES PRODUCED BY π^+d COLLISIONS AT 1.5 GeV/c. Katz, Philip Arthur. Minneapolis; Univ. of Minnesota (1971). 118p. University Microfilms Order No. 71-22,215.

Thesis.

The results presented were obtained from a bubble chamber analysis of π^+d collisions at 1.5 GeV/c. The experiment consists of an analysis of the eta, omega and rho mesons whose production dominates the π^+n interaction. A survey of the theoretical background for peripheral production is discussed. The theory for the mixing of the rho and omega mesons via the electromagnetic interaction is presented by use of the mass matrix formalism. Predictions for $\rho-\omega$ interference effects in the $\pi^+\pi^-$ mass spectrum for Reggeized π and B exchange dominating the ρ and ω production are made and the predictions are compared to available experimental data. The experimental details of the experiment are then discussed including the modifications made to the 7° beam at the ZGS to achieve the best momentum resolution consistent with the necessary beam intensity. The one-constraint fits to $\pi^+n \to p\omega$ are analyzed to determine the mass and natural width of the omega, and a Regge pole model fit to the density matrix elements is presented. The four-constraint fits to $\pi^+n \to p\pi^+\pi^-$ are analyzed to examine the effects of $\rho-\omega$ interference via the electromagnetic interaction. Fits to the $\pi^+\pi^-$ mass spectrum are presented for a pure rho plus phase space description and for the sum of coherent contributions from the normal $\rho \to 2\pi$ decay and the G-parity violating $\omega \to 2\pi$ decay. The spin density matrix elements for the rho are then compared to the predictions of a one-pion exchange model with absorptive corrections and to the predictions of a Reggeized exchange. (Diss. Abstr. Int., B)

5732 FORWARD RHO PRODUCTION AND DECAY IN THE INTERACTION OF 5 GeV/c NEGATIVE PIONS WITH PROTONS. Byerly, William Louis. Ann Arbor, Mich.; Univ. of Michigan (1970). 166p. University Microfilms Order No. 71-23,715.

Thesis.

The production and decay distributions of forwardly produced, negative rho mesons from the reaction 5 GeV/c $\pi^- + p \to \rho^- + p$ are measured as a function of squared four momentum transfer to the proton and mass of the dipion system. Only events with intermediate squared four-momentum transfer ($-.05 > t > -.35$ GeV/c^2) are studied. The outgoing particles are observed in a system of spark chambers and scintillation counters. The time-of-flight of the slow recoil proton is measured directly, thereby giving a measurement of the momentum of the final state proton. The momentum of the higher momentum negative pions from the rho decays is measured in a magnetic field, and the gamma rays from the decay of the neutral pion are converted in a lead plate. Of the more than 8000 events identified as $\pi^- + p \to p + \pi^- + \pi^\circ$ events 5113 have a dipion mass in the rho region (from 660 to 860 MeV/c^2). Due to the asymmetrical up-down positioning of the magnet, only those events which have the negative pion above the production plane (2731) are used to study the angular decay distribution. The rho decay is studied in terms of spin density matrix elements in both the Gottfried-Jackson frame and the helicity frame. Although the production cross section agrees with the predictions of adsorption-modified one-pion-exchange (OPEA), the measured density matrix elements disagree with the OPEA predictions. The density matrix elements are found to be strongly dependent on dipion mass. For low dipion masses in the rho region the density matrix elements agree well with OPEA plus ω exchange contributions. However, for higher dipion masses in the rho region the matrix elements become qualitatively more like those of pure OPEA. (Diss. Abstr. Int., B)

5733 $K^-n \to \Sigma^-\eta$ NEAR THRESHOLD. Chu, Robert Yuen-lup. Medford, Mass.; Tufts Univ. (1971). 152p. University Microfilms Order No. 71-22,629.

Thesis.

The reaction $K^-n \to \Sigma^-\eta$ was studied near threshold with bubble chamber pictures of K^-d interactions at incident momenta of 925 and 959 MeV/c. The η was detected as a missing mass quantity. A maximum likelihood fit to the differential cross section yields the following values of the coefficients of the Legendre polynomials: $A_2/A_0 = 0.56 \pm 0.25$ and $A_4/A_0 = 0.16 \pm 0.35$. The latter is consistent with zero and is in disagreement with the CERN-Heidelberg-Saclay collaboration. The shape of the cross section is compatible with resonant behavior. A chi-square fit to a spin ½ Breit-Wigner resonance gives the values of mass = 1776 ± 12 MeV and width = 93 ± 45 MeV. The maximum cross section appears to be smaller than the results of previous investigations. The possible spin parity assignments are $\frac{1}{2}^+$, $\frac{1}{2}^-$, $(3/2)^+$ and $(3/2)^-$. (Diss. Abstr. Int., B)

5734 STUDY OF Ξ^-, Ω^-, AND FIVE PRONG EVENTS IN K^- DEUTERIUM INTERACTIONS AT 4.92 GeV/c. Endorf, Robert Joseph. Pittsburgh; Carnegie-Mellon Univ. (1971). 186p. University Microfilms Order No. 71-24,106.

Thesis.

A study is made of Ξ^-, Ω^- and five prong events from K^- deuterium interactions in the 80-inch BNL deuterium-filled bubble chamber exposed to a beam of 4.92 GeV/c K^- mesons. The Ξ^- events from both K^-p and K^-n interactions were analyzed. The K^-p and K^-n cross sections are similar. The maximum Ξ^- cross sections are four body production. A search for Ξ^* resonance states decaying into a Ξ^- and one or more pions reveals strong $\Xi^*(1530)$ production and weaker evidence for Ξ^* states at 1800 to 1850 MeV/c^2 and 2000 to 2050 MeV/c^2 which decay into $\Xi^{*0}(1530)\ \pi^{-0}$ or $\Xi^-\pi^+\pi^{-0}$. Evidence is also observed for Y* resonances at 2500 to 2650 MeV/c^2 in $M(\Xi^-K^0\pi^+)$ and at 2000 to 2050 MeV/c^2 in $M(\Xi^-K^+)$. The $K^*(890)$ is the only meson resonance produced in the Ξ^- data. The Ξ^- mass, lifetime, and decay asym-

metry parameter are measured as 1321.46 ± 0.34 MeV/c^2, (1.67 ± 0.08) × 10^{-10} sec and −0.40 ± 0.19 respectively. Four new Ω^- events were discovered. Two events result from K^-p interactions and two from K^-n interactions. For both the K^-p and K^-n interactions one event has an $\Omega^- \to \Xi^0\pi^-$ decay mode and one event has an $\Omega^- \to K^-\Lambda$ decay mode. The mass of the Ω^- was measured from these events as 1374.0 ± 1.7 MeV/c^2. The following five prong final states were studied in detail: $K^-p\,\pi^-\pi^-\pi^+$, $K^-p\,\pi^-\pi^-\pi^+\pi^0$, and $K^-n\,\pi^-\pi^-\pi^+\pi^+$. Their cross sections are 255 ± 28 μb, 308 ± 35 μb, and 223 ± 22 μb, respectively. A search for resonance production in these final states yields the following resonances: Λ(1520), Δ^{++}(1236), K*(890), and ω. Statistically smaller signals are observed for Σ^+(1910), Δ^{0+}(1236), K*−(890), K*−(1420), and a $\pi^-\pi^-\pi^+$ resonance at ~1000 MeV/c^2. (Diss. Abstr. Int., B)

5735 SOME PROPERTIES OF THE CHARGED Σ HYPERONS. Tovee, D. N. (University Coll., London); Davis, D. H.; Simonovic, J.; (and others). Nucl. Phys.; B33: No. 2, 493-504(1971).

A sample of some 7500 K^- meson captures at rest on hydrogen in emulsion giving rise to charged Σπ pairs was used to determine r, the decay branching ratio of the Σ^+ hyperon, γ, the ratio of Σ^- to Σ^+ hyperon production, τ_{Σ^-}, the lifetime of the Σ^- hyperon, and C, the mean orbital capture time of Σ^- hyperons in emulsion. The results obtained are r = 0.484 ± 0.015, γ = 2.34 ± 0.08, τ_{Σ^-} = (1.41 ± 0.08) × 10^{-12} sec, and C ≲ 10^{-12} sec. (auth)

5736 ANALYSIS OF THE $YK\bar{K}$ AND $\Xi^0K^+\pi^-$ THREE BODY FINAL STATES FROM K^-p INTERACTIONS AT 2.9 GeV/c. Stottlemyer, Alan Roy. College Park, Md.; Univ. of Maryland (1971). 99p. University Microfilms Order No. 71-25,969.

Thesis.

The three body final states $\Lambda^0K\bar{K}$, $\Sigma K\bar{K}$ and $\Xi^0K^+\pi^-$ produced by K^-p interactions have been analyzed at a K^- beam momentum of 2.9 GeV/c. This is a part of the analysis of a 40 event/microbarn exposure of K^- mesons in hydrogen being studied by the Brandeis−Maryland−Syracuse−Tufts collaboration. The primary purpose of the experiment is a study of strangeness-2 baryon states at a single momentum. Evidence is presented for the existence of at least one such resonance with a mass of about 1860 MeV. There is a large sample of φ mesons, produced in both the $\Lambda^0\phi$ and $\Sigma^0\phi$ final states. The mass and width of the φ have been measured, and the results are compatible with existing data. The $\Lambda\phi$ and $\Sigma^0\phi$ production t distributions are given, illustrating a possible difference in the production mechanisms for the two final states. The production cross sections are determined for all reactions presented. The effective exposure is about 30 events/microbarn for the $\Lambda^0K^0\bar{K}^0$, $\Sigma^0K^0\bar{K}^0$, $\Sigma^+K^-K^0$ and $\Sigma^-K^+\bar{K}^0$ final states, and about 5 events/microbarn for the $\Lambda^0K^+K^-$, $\Sigma^0K^+K^-$ and $\Xi^0K^+\pi^-$ final states. (Diss. Abstr. Int., B)

5737 PION−PROTON ELASTIC SCATTERING AT 180° FROM .60 TO 1.60 GeV/c. Rothschild, Richard Eiseman. Tucson, Ariz.; Univ. of Arizona (1971). 72p. University Microfilms Order No. 71-24,895.

Thesis.

The differential cross section for π± proton elastic scattering at 180° was measured from 0.575 to 1.635 GeV/c at the UCLRL Bevatron utilizing scintillation counters and a double arm magnetic spectrometer. The center of mass solid angle acceptance was $-1.00 \le \cos\theta^* \le -0.9992$. The π^+p differential cross sections exhibit a large dip at 0.741 GeV/c and a broad peak centered about 1.32 GeV/c. The π^-p differential cross sections exhibited peaks at 0.69, 0.98, and 1.44 GeV/c. The variation in cross section with momentum appears to be smoother than predicted by most phase shift analyses. (Diss. Abstr. Int., B)

5738 STUDY OF V^0 FINAL STATES IN K^-d INTERACTIONS AT 5.5 GeV/c. Johnson, Denis P. Lawrence, Kan.; Univ. of Kansas (1971). 217p. University Microfilms Order No. 71-27,159.

Thesis.

A study of $\bar{K}^0$ and Λ^0 final states was made in a deuterium bubble chamber exposed to an incident K^- meson beam of 5.5 GeV/c. The topologies studied were one and two-charged prongs plus a V^0. The final state $\pi^-\Lambda^0(p_s)$ was found to be produced peripherally with a strong forward peak and a much smaller backward peak. The forward cross section and the slope of the production angular distribution were compared with data for the line-reversed reaction $\pi^-p \to K^0\Lambda$ in an attempt to study K*, K** exchange degeneracy. These data indicate a failure of exchange degeneracy for the $\pi^-\Lambda^0(p_s)$ final state. On the other hand, observation of polarization data for the Λ^0 compared well with that predicted by an FESR model using weak exchange degeneracy for K*, K**. Production of the Y_1^{*-0}(1385) and ρ^-(760) represents the most striking effects in the $\pi^-\Lambda^0\pi^0(p_s)$ final state. The ρ-decay density matrix elements indicate a dominance of vector exchange in the production process. It was found that $\bar{K}^{*-}$(890) and $\bar{K}^{*-}$(1420) are coherently produced with very little background in the final state $\bar{K}^0\pi^-$d. The decay angular distributions for the $\bar{K}^{*-}$(890) are entirely consistent with those expected from ω^0 exchange. Moreover, the t-distribution for the $\bar{K}^{*-}$(890) was consistent with the distribution $F^2(q)\,e^{-6t}$, where F^2 is the deuteron form factor squared and e^{-6t} represents the four momentum transfer dependence expected for ω^0 exchange off a free nucleon. Events of the final state $\bar{K}^0\pi^-n(p_s)$ show striking enhancements corresponding to $\bar{K}^{*-}$ and Δ^- production. Vector exchange (ω^0) is the primary production mechanism for the $\bar{K}^{*-}$ which also shows a forward dip in the differential cross section. The Δ^-(1236) decay density matrix elements are in accord with a previous M1 vector dominance model. The study of Δ^-(1236) production in association with the line-reversed reaction $K^+p \to K^0\Delta^{++}$ provides still another check on the hypothesis of exchange degeneracy (i.e., for $\rho - A_2$). The data clearly rule out strong exchange degeneracy, although weak exchange degeneracy together with Regge cuts may provide an adequate explanation for the data. (Diss. Abstr. Int., B)

5739 STUDY OF THE $\bar{K}N$ CHANNELS IN K^-p INTERACTIONS BETWEEN 680 AND 840 MeV/c. Rice, Rose Marie. Riverside, Calif.; Univ. of California (1971). 75p. University Microfilms Order No. 71-30,384.

Thesis.

The reactions $K^- + p \to K^- + p$ and $K^- + p \to \bar{K}^0 + n$ were studied at eight incident K^- moments between 690 and 840 MeV/c. There were 30,000 pictures at each momenta taken in the 30″ liquid hydrogen bubble chamber at Brookhaven National Laboratory. About 500 events/mb are obtained at each momentum. Results are presented on the behavior of the cross sections, angular distributions, and Legendre polynomial coefficients, as a function of K^- momenta. An attempt is made to relate the results to the multiple Y_δ^* and Y_1^* hyperon resonances which fall in the region M* = 1650 to 1720 MeV. The well established resonances Λ(1670) and Λ(1690) are required by the data. The elasticity obtained for the Λ(1670), 0.53 ± 0.05, is larger than was previously reported. Two acceptable solutions were found. However, it is impossible to distinguish between them. Both required the D_{13} partial wave amplitude. The first has a D_{13} background amplitude, and the second has a D_{13} resonance with an assigned mass and width. (Diss. Abstr. Int., B)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 5855.

5740 (CONF-690217-(Ch.2)) 4th WINTER SEMINAR ON THE THEORY OF THE NUCLEUS AND THE PHYSICS OF HIGH ENERGIES, LENINGRAD, USSR, FEBRUARY 5–17, 1969. CHAPTER II. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1969. 316p. (In Russian).

The conference included 14 papers. Separate abstracts were prepared for 13 papers. The other paper was outside the scope of NSA. (J.F.P.)

For abstracts of individual papers see: 5698, 5703, 5704, 5741, 5742, 5783, 5811−5814, 5940, 6113, and 6114.

5741 (CONF-690217-(Ch.2), pp 3-23) STATISTICAL TREATMENT OF EXPERIMENTAL DATA AS A MEANS OF OBTAINING FALSE RESULTS. Shekhter, V. M. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Using examples, it is explained how an incautious application of statistical methods could lead to erroneous results. A number of new resonance states of elementary particles have recently been reported, based on mass distribution observations. Valid observations can only be drawn from five standard deviations. With reference to the "snowman" effect, it is stated that although the appearance of statistical fluctuations in the same place on different experiments is extremely unlikely, the number of experiments becomes so large that is is impossible to disregard this possibility. The chi-squared method is discussed, and the relation between physical criteria and artificial selection of circumstances is analyzed. (K.S.W.)

5742 (CONF-690217-(Ch.2), pp 234-50) AMPLITUDE RESOLUTION OF PARTICLE INTERACTION WITH ARBITRARY SPINS ACCORDING TO INVARIANT FORM FACTORS. Kolybasov, V. M.; Marinov, M. S. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

The problem of amplitudes of a reaction through invariant form factors leads to the construction of an invariant relatively rotating combination of spin wave functions. The case of the bispinor formalism was examined starting with a Lorentz transformation of vectors. The construction of invariant amplitudes, and the subjects of peak functions and scattering amplitudes were discussed. (K.S.W.)

5743 MODIFIED CLASSIFICATION SCHEME FOR ELEMENTARY PARTICLES. Westenholz, C. V. (Univ., Muenster, Ger.). Ann. Inst. Henri Poincare, Sect. A; 14: No. 4, 285-93 (1971).

A modified classification scheme for the different elementary particle families known (baryons, mesons, baryon resonances, etc.) is proposed. Contrary to the familiar symmetry classifications with higher unitary symmetries this classification model admits nontrivial mixings between the inhomogeneous Lorentz group and some internal interaction symmetry. One thus obtains multiplets with different masses and consequently nontrivial mass formulas. (France)

5744 ENERGY-MOMENTUM SUM RULES FOR SINGLE- AND MULTI-PARTICLE DISTRIBUTIONS. Biebl, K.-J.; Wolf, J. (Institut fuer Hochenergiephysik, Berlin). Phys. Lett.; 37B: No. 2, 197-200(15 Nov 1971).

Sum rules for n-particle distributions are obtained resulting from energy-momentum conservation. These rules imply an average limiting behavior for single particle distributions and average factorization for n-particle distributions. (auth)

5745 SOME ASPECTS OF SIMPLE PRODUCTION AMPLITUDES. Beers, Brian Lee. College Park, Md.; Univ. of Maryland (1970). 222p. University Microfilms Order No. 71-23,969.

Thesis.

The simple production amplitude ($2 \rightarrow 3$) is studied in terms of its expansion in angular momentum states (partial wave expansion) and its expansion with respect to a complete set of three body states (expansion on phase space). The central tool is the use of properties of expansions of analytic functions defined on groups and coset spaces. For the elastic amplitude, these properties are the familiar properties of Legendre expansions. (Diss. Abstr. Int., B)

5746 CLASSICAL AND QUANTAL THEORIES FOR PARTICLES WITH SPIN. Plahte, E. Vollebekk, Norway; Agricultural College of Norway (1970). 43p.

Reprints of three papers, NSA 21: 3963, NSA 21: 3944 and "Classical Hamiltonian theory for particles with spin" (Physica Norregica, V. 3, No. 3, 1969) are supplemented by a fourth paper in which the classical equations of motion for particles with spin first established by Frenkel, are written in a new way which implies major advantages: the structure of the equations is more apparent; they may be solved exactly for a free particle; assuming no Zitterbewegung, the exact solution may be found for constant external electromagnetic fields; they admit an iterative solution in powers of the particle's charge for arbitrary external fields. The latter is performed to first order for constant and homogeneous external fields. Due to the existence of Zitterbewegung the motion is very complicated. A straightforward interpretation of the variables is hardly feasible. Some alternatives are discussed. It is shown that in the limit of vanishing Zitterbewegung, the magnetic moment factor takes on its "normal" value. Implications of this are discussed. (Norway)

5747 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 19, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 68p.

5748 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 20, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 71p.

5749 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 21, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 67p.

5750 TWO TOPICS IN PARTICLE PHYSICS: TESTS FOR HELICITY CONSERVATION AND SPIN-PARITY SELECTION RULES IN DIFFRACTION DISSOCIATION AND INDEPENDENT PRODUCTION OF PIONS. Silver, Richard Neil. Pasadena, Calif.; California Inst. of Tech. (1971). 127p. University Microfilms Order No. 71-27,110.

Thesis.

A phenomenological discussion of diffraction dissociation is presented in which the development of experimental tests for its conjectured properties is emphasized. Of particular interest is the problem of distinguishing between the behavior of resonances and background. Simple tests for the helicity, spin-parity, and internal quantum number selection rules proposed for resonance production would be possible only if the nonresonant background were absent. These would include an isotropy in azimuthal angle test for helicity conservation and a symmetry under parity inversion test for the Chou-Yang and Carlitz-Frautschi-Zweig rules. The more general and realistic case is that in which nonresonant background is present as well as resonances. It is found that a nonresonant pion exchange mechanism can account for the production characteristics of the broad low mass enhancements seen in present diffraction dissociation data. These include the variation of momentum transfer dependence with invariant mass and the spin-parity of the enhancements. It is unlikely that this background obeys the selection rules expected of resonance production. Nevertheless, the rapid variation in phase and possibly high spins of resonance contributions when interfered with the slow variation in phase and predominantly low spins expected of a pion exchange contribution should make possible tests for resonance production selection rules given adequate statistics. Theoretical limitations on the possibility that multiparticle experiments at high energies are dominated by the independent production of uncorrelated pions are investigated. A description of pion production in coherent states is developed in order to systematically study the effects of conservation laws. Charge conservation leads to modifications of Poisson distributions for charged particle production in purely hadronic reactions that agree well with experiment. Other systems such as $e^+e^- \rightarrow$ pions are so limited by charge conjugation considerations that production of uncorrelated pions is ruled out. A formalism for the isospin analysis of pions with identical momentum distributions is developed and applied to coherent states. The fixed phase of a coherent state is important for minimizing the increase of $\langle I^2 \rangle$ with $\langle n \rangle$. The minimum that can be achieved with independent uncorrelated pions is a random walk in isospace. In this case the dominant contributions at present multiplicities come from the lowest isospins so that independent and coherent pions can be an approximation to experiment. Finally, the role of two pion correlations is studied. Independent emission of isoscalar pairs of pions solves the isospin problem and gives reasonable distributions of charged pions, but leads to negative correlations between charged and neutral pions that seriously disagree with experiment. Emission of charged isovector pairs of pions would improve the agreement with the observed slightly positive correlations. It is concluded that the effects of the many possible correlations may be difficult to resolve in the present analysis of existing data. (Diss. Abstr. Int., B)

5751 RENORMALIZED σ-MODEL. Kim, Kwang Je. College Park, Md.; Univ. of Maryland (1971). 105p. University Microfilms Order No. 71-25,247. Thesis.

Some of the properties of the renormalized perturbation theory of the so-called σ model, where the chiral symmetry is broken only by a source term of $\sigma(x)$, are considered. To do this, the elegant Brandt-Wilson procedure of renormalization is employed. It is first shown that when a symmetry is broken by a source term, then the form of the renormalized current operator can be chosen to be the same as the one given in the symmetric case except for the source term itself. Then some of the structures of the model are analyzed in detail in the framework of the perturbation theory. In particular, Ward identities are proved to all orders in the perturbation theory. (Diss. Abstr. Int., B)

5752 RELATIVISTIC AND REALISTIC CLASSICAL MECHANICS OF TWO INTERACTING POINT PARTICLES. Fronsdal, Christian (Univ. of Californic, Los Angeles). Phys. Rev., D; 4: No. 6, 1689-1706(15 Sep 1971).

Classical mechanics of two point particles interacting at a distance is given a Lorentz-covariant formulation without introducing unphysical degrees of freedom such as usually accompany the two-time formalism. The theory is then quantized and compared with quantum field theory to allow the determination of realistic potentials. Exact solutions are obtained for an inverse distance potential; classical orbits as well as quantum energy levels are determined. (auth)

5753 EQUAL-TIME TERMS IN PERTURBATION THEORY AND CONVOLUTIONS OF TEMPERED DISTRIBUTIONS. Otterson, Paul (New York Univ., N. Y.). Phys. Rev., D; 4: No. 6, 1681-9(15 Sep 1971).

The matrix elements of commutators of local operators are expressed in terms of the corresponding time-ordered products to all orders of perturbation theory. An ambiguity in the definition of retarded commutator is resolved by demanding that two versions of the Lehmann-Symanzik-Zimmermann reduction formula agree. It is shown that when the equal-time commutator is sequence-independent, it agrees with the appropriately defined equal-time limit of the retarded commutator. The method enables one to rigorously obtain non-c-number Schwinger terms directly from Feynman diagrams, and to determine their significance in sum

rules. A generalized convolution is introduced and a convolution theorem is proved which makes rigorous the correspondence between equal-time commutators and sum rules. (auth)

5754 WAVE EQUATIONS AND SATURATION OF CURRENT ALGEBRA FOR I = ½. Niederer, U. H.; O'Raifeartaigh, L. (Dublin Inst. for Advanced Studies). Phys. Rev., D; 4: No. 6, 1896-1906(15 Sep 1971).

The conditions imposed by the saturation of the isospin-factored current algebra are studied for a class of currents which includes the canonical currents belonging to second-order wave equations. The aim is to understand in a simple, transparent way the nature and extent of the conditions imposed by current algebra, and to see how, in particular models, these conditions reduce more general wave equations to the special form $(ap^2 + 2g \cdot p + s)\psi(p) = 0$ predicted by earlier work. A recently proposed wave equation which appears at first sight to contradict the prediction is shown to contain no contradiction. (auth)

5755 PECULIAR PROPERTIES OF TACHYON SIGNALS. Parmentola, J. A.; Yee, D. D. H. (Polytechnic Inst. of Brooklyn). Phys. Rev., D; 4: No. 6, 1912-14(15 Sep 1971).

The gedanken experiment as introduced recently by Pirani to demonstrate the noncausal behavior of classical tachyons is reconsidered and analyzed in Minkowski space. Upon adhering to the principles used by Sudarshan and Feinberg with respect to the possible existence of tachyons, it is shown that the noncausal behavior of classical tachyons as deduced from this experiment is inconclusive. (auth)

5756 PARTICLES INTERACTING THROUGH A MEDIUM. I. CLASSICAL GALILEAN THEORY. Pearle, Philip (Hamilton Coll., Clinton, N. Y.). Phys. Rev., D; 4: No. 6, 1626-34(15 Sep 1971).

An analysis is presented of any Galilean-invariant classical Hamiltonian theory in which the particles do not interact directly with each other, but interact directly with a number of other dynamical variables. These other dynamical variables are collectively called "the medium." It is shown that only 12 of the variables which describe the medium are crucial for the Galilean invariance of the theory. The generators of Galilean transformations are constructed in their most general form. An example is given. Galilean-invariant approximations to Galilean-invariant theories are discussed. (auth)

Electromagnetic

5757 (UCRL-Trans-10557) COULOMB AND YUKAWA POTENTIAL GROUPS. Wyler, Armand. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Compt. Rend., Ser. A; 272: 186-8(11 Jan 1971). 5p. Dep. NTIS.

Green functions for symmetric spaces are associated with Coulomb and Yukawa potentials. This construction leads to an interpretation of the ratio between the masses of the particles which produce these force fields. (auth)

5758 QUASI-RELATIVISTIC N-FERMION PROBLEM AND ITS REDUCTION TO THE PAULI FORMALISM. Hanus, W.; Janyszek, H. (Nicholas Copernicus Univ., Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 7, 659-62(1971).

A new quasirelativistic equation (different from that of Brait) for N-fermions interacting with each other as well as with the external electromagnetic field was proposed together with a new method of reducing such equations to the Pauli formalism. (auth)

5759 ANALYSIS OF THE SPECTRA FOR ELECTRON SCATTERING ON PROTONS AND DEUTERONS. Ganichot, D. (Ecole Normale Superieure, Orsay, France); Grossetete, B.; Isabelle, D. B. Nucl. Instrum. Methods; 96: No. 4, 525-37 (1971). (In French).

A method to compute the spectrum shape for electron scattering at high energies is described. It includes all radiative effects occurring on the scattering nucleus or due to the finite target thickness and window foils. It also takes into account beam and counter dispersions. Practical formulas to be used in a computer code are derived and the general lay-out of the code is described. Applications to cases of electron scattering on proton and deuteron targets are given. (auth)

5760 RATE OF ENERGY LOSS DUE TO IONIZATION AND RANGE–ENERGY RELATION IN CsI. Paul, J. M. (Louisiana State Univ., Baton Rouge). Nucl. Instrum. Methods; 96: No. 4, 539-49(1971).

The rate of energy loss due to ionization in CsI has been calculated for muon, pion, kaon and proton in the energy interval 10^1 to 10^5 MeV, taking into consideration both the shell correction and density effect terms. The ranges of muon, pion, kaon, proton, deuteron, triton, ^{3}He and ^{4}He have also been calculated up to 10^4 MeV. The fwhm and most probable energy loss in thin absorbers have been calculated for four different thicknesses of CsI (0.2, 0.5, 1.0 and 2.54 cm) covering the range of interest in both high energy physics and cosmic rays. (auth)

5761 HYDROGEN HYPERFINE STRUCTURE AND INELASTIC ELECTRON PROTON SCATTERING EXPERIMENTS. De Rafael, E. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Phys. Lett.; 37B: No. 2, 201-3(15 Nov 1971).

It is shown that present experiments on inelastic electron proton scattering can be used to set bounds to part of the proton polarizability contribution to the hyperfine structure of the ground state in the hydrogen atom. (auth)

5762 EXTENDED NUCLEON AND PION PROPAGATORS IN RADIATIVE MUON CAPTURE. Yano, A. F. (California State Coll., Long Beach); Yano, F. B.; Rood, H. P. C. Phys. Lett.; 37B: No. 2, 189-91(15 Nov 1971).

The effect of the finite size of the proton and pion propagator on the photon spectrum in radiative muon capture is investigated. (auth)

5763 RADIATIVE PICTURE FOR THE NUCLEON ANOMALOUS MAGNETIC MOMENTS IN THE SIDEWISE DISPERSIVE FRAMEWORK. Mackey, Jacob Edward Jr. Columbus, Ohio; Ohio State Univ. (1971). 77p. University Microfilms Order No. 71-22,503.

Thesis.

The calculation of the nucleon anomalous magnetic moments is investigated in the sidewise dispersive framework in which the intermediate states are inserted into the incoming nucleon channel instead of the photon channel as in the conventional dispersive framework. In analogy with the situation for the electron anomalous magnetic moment, the presence of meson–baryon intermediate states in the sidewise dispersive framework presents a low-energy radiative picture for the nucleon anomalous magnetic moments. Using a realistic photoproduction amplitude, it is shown that the meson–baryon vertex cannot be approximated by constant form factors in order for the meson–baryon states to give the dominant contribution. The form factors must, in fact, show a peaked behavior in the low energy region in order to compensate for the rapidly falling photoproduction factor. In this manner, the moderately successful results obtained by Drell and Pagels in the threshold dominance approximation can be understood. The peaked behavior in the meson–baryon vertex can similarly be obtained by the sidewise dispersive technique in the approximation of retaining only meson–baryon intermediate states. In terms of a radiative picture, this corresponds to the insertion of a meson–baryon scattering amplitude into the original electromagnetic dispersive diagram. With the inclusion of higher intermediate states other than the dominant meson–baryon states, it appears that the sidewise dispersive approach can furnish an accurate estimation of the nucleon anomalous moments. Hopefully, when sufficient information becomes available, the entire octet of baryon anomalous moments will by dynamically accounted for in the sidewise dispersive framework. (Diss. Abstr. Int., B)

5764 SUBTRACTION RENORMALIZATION APPLIED TO ELECTROMAGNETIC CORRECTIONS TO NEUTRON BETA DECAY MEDIATED BY A VECTOR BOSON. Nack, Myron L. New York; Yeshiva Univ. (1971). 60p. University Microfilms Order No. 71-23,928.

Thesis.

The utilization of the 4-vector field developed by Goldberg, Haller, and Landovitz to mediate the weak interaction allows the performance of a cutoff independent calculation of the neutron beta decay rate to $O(\alpha)$. The linear form of this field, as developed in preceding work, will be employed. Subtraction renormalization is used to remove divergences, and the self-energy functions for the fermion and boson cases are studied and calculated to $O(\alpha)$. Past improper treatment of the fermion self-energy function is observed, and a necessary infrared divergent contribution to $O(\alpha)$ is exhibited. An algebraic simplification is employed in expressing the boson self-energy function. A general formalism for corrections to $O(\alpha)$ of neutron beta decay is given, such that the total spectrum is the sum of an $F(x)$ contained in all theoretical approaches, and a J-function which is independent of x and distinguishes each approach. The J-function is then compared to those of past cutoff dependent and independent approaches. (Diss. Abstr. Int., B)

5765 s-CHANNEL HELICITY CONSERVING AMPLITUDE FOR THE REACTION $\gamma p \rightarrow \rho^0 p$, AND ITS DUAL EXTENSION TO $\gamma p \rightarrow \pi^+\pi^- p$. Dewey, P.; Humpert, B. (Univ. of Cambridge, Eng.). Nucl. Phys.; B33: No. 2, 589-604(1971).

A pomeron exchange model which conserves s-channel helicity is constructed for the photoproduction reaction $\gamma p \rightarrow \rho^0 p$. From this basis a dual model which conserves s-channel helicity at the rho-meson pole is constructed for the reaction $\gamma p \rightarrow \pi^+\pi^- p$. The model is compared to experimental data. (auth)

5766 CLASSICAL FIELD MODEL PREDICTIONS FOR ELECTROPRODUCTION OF NUCLEON RESONANCES. Pritchett, P. L. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Phys.; B33: No. 2, 573-88(1971).

A more realistic calculation of electroproduction of nucleon resonances is performed within the framework of a previously developed model of oscillations of the meson field in the nucleon. The nucleon source and the ground-state meson field are determined from the elastic form factors, and the excitations of the meson field are described by continuum wave functions. The absolute cross sections thus obtained are in satisfactory agreement with the data on excitation of the higher resonances. (auth)

5767 CLOSURE APPROXIMATION IN DEUTERIUM AND NON-DIFFRACTIVE AMPLITUDES IN ρ^0 PHOTOPRODUCTION. Julius, David I. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B33: No. 2, 558-72(1971).

Formulas are derived for the extraction of amplitudes for natural parity non-charge-exchange reactions from deuterium and ^{3}He cross section data. For ρ^0 photoproduction, the results can be used in conjunction with those of Bethe–Heitler interference measurements to provide a determination of both the modulus and phase of the isospin one exchange production amplitude. Inadequacies of existing analyses of deuterium data for this reaction are pointed out. An investigation is made of the accuracy of the closure approximation in deuterium, the results of which are applicable generally to non-charge-exchange hadronic processes with the exception of those proceeding via one pion exchange. (auth)

5768 PHOTO-PRODUCTION OF AN ELECTRON–POSITRON PAIR IN A MAGNETIC FIELD. Korovina, L. I.; Pavlova, O. S. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 156-8(1971). (In Russian).

The process of creating an electron-positron pair by two photons in a magnetic field, pertaining to the number of processes of the second order according to the constant of electromagnetic interaction, is discussed. In contrast to a single-photon event, this process is permitted in the absence of a magnetic field. Pair production may be represented as an electron transition from a negative energy state to a positive energy state. The Dirac equation and its solution may be introduced as the wave function of an electron in a magnetic field. (K.S.W.)

5769 EXTENSIONS OF GLAUBER MODEL OF HIGH ENERGY SCATTERING TO NON-HADRONIC INTERACTIONS. Czyz, W. (Inst. of Nuclear Physics, Krakow). pp 335-42 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The applicability of the Glauber model to high energy electrodynamical processes is discussed. As an example the amplitude for Delbruek scattering is calculated. (L.B.S.)

5770 MINIMUM-UNCERTAINTY STATES $|\gamma\rangle$ AND THE STATES $|n\rangle_\gamma$ OF THE ELECTROMAGNETIC FIELD. Bertrand, P. P.; Moy, K.; Mishkin, E. A. (Polytechnic Inst. of Brooklyn, N. Y.). Phys. Rev., D; 4: No. 6, 1909-12(15 Sep 1971).

Two vector bases suitable for the representations of states of the electromagnetic field are introduced. The minimum-uncertainty states $|\gamma\rangle$ form an overcomplete nonorthogonal set. The $|n\rangle_\gamma$ states form a complete orthogonal set. The various relations they satisfy are derived via an oscillator frequency transformation. The corresponding similarity transformation of the nonnormal operator changes the physical character of its characteristic states. The photon statistics of the states $|\gamma\rangle$ and $|n\rangle_\gamma$ are shown to display anticorrelation effects. (auth)

5771 THE $\pi^+ - \pi^0$ MASS DIFFERENCE USING GRAVITY-MODIFIED HADRON ELECTRODYNAMICS. Duff, M. J.; Huskins, J.; Rothery, A. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 4: No. 6, 1851-5(15 Sep 1971).

Computations of gravity-modified hadron electrodynamics are performed using nonpolynomial Lagrangian field-theory techniques. In particular, it is shown that the infinity encountered in a standard Lagrangian approach to the electromagnetic mass difference of pions is removed. The numerical value obtained for the mass shift is a little high, but consideration of the effects of tensor-meson dominance of gravity leads to a closer agreement with experiment. (auth)

5772 ASYMPTOTICS IN ENELASTIC ELECTROPRODUCTION AND PHOTOABSORPTION. Pestieau, Jean (Instituto Politecnico Nacional, Mexico City). Phys. Rev., D; 4: No. 6, 1827-32(15 Sep 1971).

It is shown that the use of normalizable states in quantum field theory strongly suggests that scattering processes at high energies may be determined solely by light-cone contributions. Then configuration-space analysis of electromagnetic current commutators and observed behaviors of photoabsorption and of inelastic electron-proton scattering imply that scaling for deep-inelastic electroproduction cannot be related to a diffractive mechanism and that the scaling limit of $\nu W_2(Q^2,\nu)$ and $W_1(Q^2,\nu)$ is broken when $\omega = Q^2/2M\nu$ is very small ($\omega \ll 0.05$). It is shown that the results are consistent with the observed scaling behavior, the parton model, and duality. (auth)

5773 TESTS OF LIGHT-CONE COMMUTATORS: FIXED-MASS SUM RULES. Dicus, Duane A.; Jackiw, Roman; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 6, 1733-54(15 Sep 1971).

By use of light-cone commutators, corrected versions of six infinite-momentum sum rules are derived. The light-cone commutators are given by bilocal operators whose matrix elements are shown to be Fourier transforms of deep-inelastic-scattering structure functions. A modification of the Bég sum rule is found, and a sum rule for the axial-vector coupling constant in terms of a nucleon (spin-flip) structure function is presented. The latter is related to an old result of Bjorken. The full spin-dependent forward Compton amplitude is treated and the form-factor decomposition of the bilocal operators which give the fermion-quark-model light-cone commutators is discussed in detail. The model dependence of the present results is discussed, and boson-model commutators are given for comparison. (auth)

5774 RELATIVISTIC VERSUS NONRELATIVISTIC FORM FACTORS. Pavkovic, Marko I. (Tel-Aviv Univ., Israel). Phys. Rev., D; 4: No. 6, 1724-32(15 Sep 1971).

A distinction is made between relativistic and nonrelativistic form factors from the group-theoretical point of view. The unitary representations of SL(2,C) are used to describe the relativistic form factors; those of the Euclidean group E_3 are used to describe the nonrelativistic form factors. Different asymptotic behavior of the associated group representation matrix elements in the limit of large momentum transfers q results in different rates of decrease of the form factors when $q \rightarrow \infty$. This explains several hitherto puzzling features of the form factors connected with the transition from the nonrelativistic to the relativistic kinematical domain. The question of whether it is possible to obtain the relativistic form factor from the known nonrelativistic form factor is answered by an explicit construction. It is advised that the ensuing formula be utilized primarily in those cases where the nonrelativistic form factor of a dynamical system displays sufficiently fast decrease for q larger than an effective mass m. The significance of m is explained in the text. As an example, the formula is applied to the proton form factor with the assumption that the wave function is the ground state of a harmonic oscillator. (auth)

5775 DYNAMICAL SIGNIFICANCE OF THE DIMENSIONS OF THE ELECTROMAGNETIC CURRENT. Chanowitz, Michael S. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 6, 1717-23(15 Sep 1971).

It has been suggested that the dimensions of the electromagnetic current components may determine the asymptotic energy dependence of the total cross section for electron–positron annihilation. It is shown that the validity of this suggestion depends on how badly scale invariance is broken. Unless the scale-breaking interaction is sufficiently "gentle," the dynamical significance of the dimensions is observed. (auth)

5776 DEVELOPMENTS IN THE THEORY OF NUCLEON–NUCLEON BREMMSTRAHLUNG. McGuire, James Horton. Boston; Northeastern Univ. (1969). 147p. University Microfilms Order No. 71-25,764.

Thesis.

The proton-proton and neutron-proton bremsstrahlung cross sections are calculated by including the external radiation terms to all orders in the momentum of the photon, and by using the low energy theorem to compute the internal scattering contribution to lowest order in the photon momentum. These semi-relativistic calculations, which employ a simple and reasonable off-shell extrapolation of the elastic phase shifts, not only give good agreement with existing experimental data but also indicate that the interesting off-shell effects are measurable. The low-energy theorem is considered in detail and a more general conserved current theorem is proved. This theorem states that, as a consequence of gauge invariance, the purely off-shell derivatives from the electric contributions in the external radiation terms cancel exactly to all orders in the photon momentum with corresponding purely off-shell derivatives from the internal scattering amplitude.

The effect of this theorem on the calculations is discussed. In addition the fully covariant one-boson-exchange bremsstrahlung calculation is used to derive relativistic corrections to the nonrelativistic electromagnetic interaction and, to determine the influence of negative energy states in the bremsstrahlung problem. (Diss. Abstr. Int., B)

5777 CYCLOTRON RESONANCE HARMONICS IN A QUANTIZED MAGNETIC FIELD. Gurvich, Yu. A. (Moscow State Pedagogical Inst.). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1120-32 (Sep 1971). (In Russian).

The real parts σ'_{xx} and σ'_{zz} of the diagonal components of the conductivity tensor for a system of nondegenerate and noninteracting electrons in a magnetic field H = (O, O, H) and varying electric field of frequency ω scattered by a static potential are calculated. In a quantized magnetic field σ'_{xx} passes through a maximum at $\omega = n\omega_c$ ($\omega_c = eH/mc$; n = 2, 3, 4 . . .). The oscillations are studied in detail for the case of scattering by a short-wave potential. It is found that in this case σ'_{zz} also experiences oscillations. These are much smaller than those of σ'_{xx} and for a given value of ω they exist down to a certain maximal value n which depends on the magnitude of H. The possibility of observing the oscillations is discussed and it is suggested that they were encountered in E. I. Johnson and D. H. Dickey, Physical Review B, 1, 2676. The calculation is performed with aid of the kinetic equation for the translational-invariant part of the density matrix in the Wigner representation. (auth)

5778 MULTI-STEP REACTIONS OF PARTICLES ON NUCLEI AT HIGH ENERGY. Bochmann, Gregor V. Montreal: McGill Univ. (1971). National Library of Canada, Ottawa.

Thesis.

A coupled channel optical model is used to investigate the importance of multiple production steps for coherent and incoherent reactions on nuclei. Analytic expressions for the cross section are given in the low and infinite energy limit. Detailed calculations are done for a coupled π-A_1-A_3 system. For photo-reactions on nuclei, calculations are presented within the framework of vector dominance, and are compared with experiments of incoherent ρ^0 and π^+ photo-production and photon-nucleus total cross sections. The question of the validity of vector dominance is discussed. The total neutron cross section on nuclei is calculated and compared with experiment. The possible contribution of intermediate N* states to the elastic scattering amplitude is also discussed. The effects of correlations in the nuclear wave functions on elastic and inelastic scattering at high energy are described. It is indicated how these results can be used to calculate coherent and incoherent production processes. (Diss. Abstr. Int., B)

5779 PHOTON EMISSION IN HADRON PAIR PRODUCTION IN COLLIDING ELECTRON-POSITRON BEAMS. Abdullaev, S. K.; Mukhtarov, A. I.; Nadzhafov, I. M. (Azerbaydzhan State Univ., Baku). Yadern. Fiz.; 14: No. 3, 655-60(Sep 1971). (In Russian).

Annihilation of an arbitrarily polarized e^-e^+ pair into a hadron pair accompanied by polarized photon emission, is studied. The asymmetry coefficient due to transversal-transversal polarization of the e^-e^+ pair was found and the photon circular polarization degree was determined. (auth)

5780 MAGNETIC MOMENT OF THE BOUND ELECTRON. Perelomov, A. M.; Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 3, 661-8(Sep 1971). (In Russian).

The dependence on Z of the magnetic moment of the electron bound by the Coulomb field of the charge Ze is determined both at Z < 137 and Z < 137 (i.e., in case of the "falling down to the center"). The question of the magnetic moment of the scalar particle is also considered. (auth)

5781 SPECTRA OF SECONDARY PARTICLES WITH ENERGY MORE THAN 400 MeV IN THE ATMOSPHERE. Vdovin, Yu. A.; Prokhorova, L. A. (Moscow Engineering Physical Inst.). Yadern. Fiz.; 14: No. 3, 647-54(Sep 1971). (In Russian).

The intensity and the energy distribution of the secondary electron, γ quanta and μ mesons with energy more than 400 MeV in the upper atmosphere are calculated. The calculations are based on a particular form of the energy spectrum of π mesons generated in the atmosphere by initial component of cosmic rays. The cascade theory equation is solved in the approximation A. The calculation results are compared with the experimental data. (auth)

5782 SHAPE OF THE CHERENKOV EMISSION MOMENTUM OF THE WIDE ATMOSPHERE SHOWER. Fomin, Yu. A.; Christiansen, G. B. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 14: No. 3, 642-6(Sep 1971). (In Russian).

The calculation is given of the shape and duration of the Cherenkov momentum at different distances from the axis of the wide atmosphere shower generated by the 10^{17} eV initial particle. The calculations are also given for the cascade curves in individual showers from primary particles with different atomic weight. The possibility of determining the individual cascade curve according to the shape of the Cherenkov momentum is discussed in connection with the problem of the chemical abundance of cosmic rays. (auth)

Weak

Refer also to abstract 5883.

5783 (CONF-690217-(Ch. 2), pp 154-77) RESONANCE MECHANISM OF μ^--MESON CAPTURE BY NUCLEI. Balashov, V. V.; Eramzhyan, R. A. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

The asymmetry of the angular distribution of neutrons during μ-capture is analyzed, such as $\mu^- + p \rightarrow n + \nu$. The particle-hole interaction is diagrammed. Transitions of the first forbidden type in μ-capture are discussed in connection with photonuclear reactions and with inelastic scattering experiments. The neutron spectrum of giant resonance in ^{16}N, excited during capture of μ^--mesons by an ^{16}O nucleus is considered. (K.S.W.)

5784 PREDICTION FOR NEUTRINO–ELECTRON CROSS-SECTIONS IN WEINBERG'S MODEL OF WEAK INTERACTIONS. Hooft, G.'t (Univ., Utrecht). Phys. Lett.; 37B: No. 2, 195-6 (15 Nov 1971).

Weinberg's theory of purely leptonic weak interactions can be tested in neutrino-electron scattering experiments. Cross sections must be measured as a function of the energy of the recoil electron. If Weinberg's theory is correct, then the masses of the intermediate vector bosons can be derived from the measured effective coupling constants. (auth)

5785 WEAK RADIATIVE DECAY OF THE Σ^+ and Λ HYPERONS. Farrar, Glennys Reynolds. Princeton, N. J.; Princeton Univ. (1971). 96p. University Microfilms Order No. 71-23,256.

Thesis.

Dispersion theoretic techniques supplemented with current algebra, PCAC and pole models are used to determine the amplitudes for the radiative decays of the lambda and the positive sigma hyperon. Unitarity is used to obtain a reliable lower bound on the branching ratio (rate $\Lambda \rightarrow n\gamma$)/(rate $\Lambda \rightarrow$ all) $\gtrsim 8.5 \times 10^{-4}$. (Diss. Abstr. Int., B)

5786 RESONANT INTERACTION OF AN ANTINEUTRINO WITH ELECTRONS. Yakh'yaev, R. Sh. (Azerbaydzhan State Inst., Baku). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 48-53 (1971). (In Russian).

The mathematical expressions for the cross sections $\bar{\nu}_e e \rightarrow \bar{\nu}_\mu \mu^-$ and $\bar{\nu}_e e \rightarrow \bar{\nu}'_e e'$ are developed under the hypothesis of weak interactions through intermediate vector mesons allowing for the polarization of the electron-target and muon (electron) recoil separately. An analysis of cross sections of the processes is presented, which are permissible both according to the two-component and to the four-component neutrino theory. There is also determined the degree of longitudinal polarization of the meson recoil for the interaction of an incident antineutrino (neutrino) with a polarized target in the processes $\bar{\nu}e \rightarrow \nu\mu^-$, $\nu e^+ \rightarrow \bar{\nu}\mu^+$. (tr-auth)

5787 SEMILEPTONIC DECAY OF Ω^- HYPERON AND GROSS CP VIOLATION IN STRONG CUBIC INTERMEDIATE VECTOR BOSON THEORY. Yang, Yeou-wei. Rochester, N. Y.; Univ. of Rochester (1971). 141p. University Microfilms Order No. 71-22,327.

Thesis.

The semileptonic decay of Ω hyperon is studied by using the usual current-current interaction and a Rarita-Schwinger wave function for Ω. The following quantities were calculated for Ω decays: the energy spectra of leptons and baryons, the energy correlation of lepton and baryon, the longitudinal polarization of baryon and the angular distribution of lepton from polarized Ω. The form factors are obtained by using CVC and PCAC, saturating the U(6) $\otimes$ U(6) current algebra, and SL(6) symmetry. The second case is quite different from the other two in predicting the branching ratio, polarization of baryon and the angular distribution. Gross CP violation in strong cubic IVB model is studied. This model has a Hamiltonian with CP = -1 in first order g_w (which has vanishing matrix elements because of conservation of triality). Because of the strong cubic interaction among the W's, some processes can have contributions from the g_w^3 semi-weak interaction. They also

have g_w^2 plus electromagnetic interaction contributions. These two have opposite CP values. The processes $K^+ \rightarrow \pi^+ 1\ \bar{1}$, $K_1^0 \rightarrow \pi^0 1\ \bar{1}$, $\Sigma^+ \rightarrow p 1\ \bar{1}$, and $\nu + p \rightarrow \mu + W + p$ were studied. It is found that $K^+ \rightarrow \pi^+ 1\ \bar{1}$ has the same order of magnitude contribution from weak and combination of weak and electromagnetic interactions. The possible T – noninvariance (or CP) terms are calculated. The IVB model gives much smaller contributions to the other three processes. (Diss. Abstr. Int., B)

5788 ELEMENTARY PROCESSES IN MUON PHYSICS. WEAK INTERACTION OF MUONS. Rothberg, J. E. (Univ. of Washington, Seattle). pp 43-101 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The basic properties of reactions involving muons are discussed. The weak interaction Hamiltonian and the structure of the currents are first discussed. The remaining topics covered are: the static properties of μ and ν_μ; muon decay; muconium; and muon capture. A bibliography of some of the more recent papers in muon physics is included along with general references. (L.B.S.)

5789 CURRENT ALGEBRA CALCULATION OF THE PROCESS $e^- + \nu_e \rightarrow$ HADRONS. Singh, Ram Bahadur. Boston; Boston Univ. (1972). 124p. University Microfilms Order No. 71-26,482. Thesis.

The hadron production from leptons through the weak process $e^- + \bar{\nu}_e \rightarrow$ hadrons is considered. The current-current form of the weak interaction is used for the analysis. This process is analogous to the corresponding electromagnetic process $e^- + e^+ \rightarrow$ hadrons, which is of current interest because of the advent of the colliding beam experiments. However, the analysis of this weak reaction is interesting because it involves both the vector and axial vector currents in contrast to the corresponding electromagnetic process where only the conserved vector currents are involved. Using the SU(2) × SU(2) current algebra, CVC and PCAC hypothesis for the hadronic currents, the total cross-section of the reaction $e^- + \bar{\nu}_e \rightarrow$ hadrons is related to that of the electromagnetic process $e^- + e^+ \rightarrow$ hadrons. The derivation of this relation assumes the validity of the Weinberg sum rules and hence, this relation also provides a test of the Weinberg sum rules if both the cross sections are experimentally measured. Also the asymptotic behavior of the total cross section is considered in a Lagrangian realization of the gauge field model. Using the finiteness of the Schwinger terms in the model, one has the prediction that the total cross section for the process $e^- + \bar{\nu}_e \rightarrow$ hadrons goes down faster than $1/s$ for high s, where s is the square of the center of mass energy. (Diss. Abstr. Int., B)

5790 TIME–SPACE EQUAL-TIME COMMUTATORS OF CURRENTS AND SCALING PROPERTIES OF CURRENT DIVERGENCES. Katz, J. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 6, 1929-31(15 Sep 1971).

On the basis of rather general considerations, it has been recently suggested that the equal-time commutators between the time component of an axial-vector current and the space component of a current should be modified. Such modifications lead to a natural explanation of the K_{13} form factors and the $\pi^0 \rightarrow 2\gamma$ and $\eta \rightarrow 3\pi$ decays. Moreover, examples may be constructed in which these modifications do not invalidate the usual good results of current algebra. Use is made of scaling considerations to note that such modifications imply the presence of an SU(3) ⊗ SU)3)-breaking term in the Hamiltonian density with dimension $d \geq 2$. Conversely, if $d < 2$ such modifications must be absent. Some related comments are presented. (auth)

Strong (General)

Refer also to abstract 5888.

5791 RELATIONS AMONG THE TRIPLE-, DOUBLE-, AND SINGLE-POMERON VERTICES. Mickens, R. E. (Fisk Univ., Nashville). Lett. Nuovo Cim.; 2: No. 20, 1042-4(13 Nov 1971).

It is pointed out that, in applying the hypothesis of limiting fragmentation or scaling to diffractive dissociation, it is found that the probability of diffractive dissociation into large masses is related to the triple-pomeron vertex. It is shown that if pole dominance is assumed, the triple-, double-, and single-pomeron vertices can be related. (L.B.S.)

5792 SUM RULES, MULTIPLICITY DISTRIBUTIONS, AND INCLUSIVE REACTIONS. Corbella, O. D. (Univ. Nacional, Cordoba, Spain); Gleiser, R. J.; Gallardo, J. C. Lett. Nuovo Cim.; 2: No. 20, 1045-9(13 Nov 1971).

A sum rule relating the multiplicity to the integrated inclusive cross sections for pion production is used to obtain the higher moments of the distribution as a function of these cross sections. It is concluded that the distribution of the secondary pions created is not a Poisson one, and that the departure from the simple Poisson distribution can be measured by the correlation functions. (L.B.S.)

5793 DIPS IN TWO-BODY AND QUASI-TWO-BODY HADRONIC PROCESSES AND DUAL GEOMETRICAL MODEL. Kohsaka, Y.; Takagi, F. (Tohoku Univ., Sendai). Lett. Nuovo Cim.; 2: No. 19, 965-8(6 Nov 1971).

A qualitative investigation is made of dyes in the differential cross sections and the spin density matrix elements for various two-body and quasi-two-body hadronic processes which are dominated by the pomeron and/or the vector and tensor Regge exchanges on the basis of the dual geometrical model. (L.B.S.)

5794 UNITARIZATION OF PHENOMENOLOGICAL MODELS. Greenman, J. V. (Univ. of Essex, Colchester, Eng.). Lett. Nuovo Cim.; 2: No. 20, 1057-9(13 Nov 1971).

The problem of solving the nonlinear integral equation in the crossing-symmetric unitary model by iteration procedures is considered. The analysis is simplified by taking the CHKZ amplitude (Phys. Rev. Lett., 26: 112(1971)) as a first approximation to the full amplitude defined by the strip model. A crossing-symmetric iteration procedure is then produced on the strip model. (L.B.S.)

5795 NATURAL PARITY EXCHANGE AND GRIBOV–MORRISON PARITY RULE IN DIFFRACTIVE PRODUCTION OF MESONIC SYSTEMS. Bialas, A. (Jagellonian Univ., Krakow); Dabkowski, J.; Golab-Meyer, Z. Acta Phys. Pol.; B2: No. 5, 689-93(Sep-Oct 1971).

The diffraction dissociation of pions and kaons into three particles is discussed under the following assumptions: dominance of the natural parity exchange and Gribov–Morrison parity rule. The measurable consequences of these assumptions are derived. (auth)

5796 COMPUTER SIMULATION OF A FIRE-BALL. Sato, Yoshihiro (Waseda Univ., Tokyo); Yanagita, Tomotake; Ogita, Naofumi. Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 214-45 (1971).

A computer simulation is made on multiple pi-meson emission from a fire-ball under rigorous requirement of the energy-momentum conservation and basic assumptions on its physical properties, which were obtained from the superposed data on C-jets of the Chacaltaya emulsion chamber experiment. The computer constructed about one thousand examples each for cases of the fire-ball rest-mass, 2.2, 2.4, 2.6 and 2.8 GeV/c^2 with the width of 100 MeV/c^2. Further, the simulation experiment is carried out on the C-jet observation by the producer emulsion chamber under the identical conditions with the real experiment of Chacaltaya Chamber Nos. 12 and 13. Through the simulation experiment, one is able to perform detailed investigation on the fluctuation problem and the experimental biases in measurement and analysis on the individual events. Comparison of the data of artificial C-jets and of experimental C-jets provides a method of estimation of a fire-ball rest-mass. This comparison is made on distributions of the three physical quantities of the event, the γ-ray mass (total energy released into γ-rays in the fire-ball system), the invariant mass of the detected γ-rays and the γ-ray multiplicity. Those three quantities are affected in different ways by the experimental conditions, so that their mutual consistency check allows to discuss accuracy of the mass estimation and possible systematic errors in the experimental data. The conclusion from the comparison of 70 C-jet events of the Chacaltaya experiment with the artificial ones is that the fire-ball mass-value lies between 2.2 and 2.6 GeV/c^2. In addition, the present work gives suggestions on design of the experiments and method of the analysis. (auth)

5797 THREE-BODY DECAYS OF INTERFERING RESONANCES. Dabkowski, J. (School of Agriculture, Krakow). Nucl. Phys.; B33: No. 2, 621-31(1971).

Simple rules are given which enable one to determine the relative parity of the interfering particles decaying into a three-body final state by measuring the moments of the angular distribution of the normal to the decay plane. Formulas presented exhibit the full symmetry between the parameters describing the production of resonance in quasi two-body reaction and its decay dynamics. An example of diffraction dissociation of mesons and baryons into three particles is discussed in detail. (auth)

5798 TOTAL SCATTERING CROSS SECTIONS IN TWO BODY STRONG INTERACTIONS CALCULATED BY AN ALGEBRAIC APPROACH USING THE GROUP SU(1,3). Kalman, Calvin Shea. Rochester, N. Y.; Univ. of Rochester (1971). 287p. University Microfilms Order No. 71-22,300.

Thesis.

A method is developed for the calculation of total scattering cross sections in two body strong interactions by an algebraic approach using the group SU(1,3). A general discussion of the method, its historical development and a possible theoretical basis is presented. Since the details involve a thorough understanding of the methods of group theory, a presentation of the classical method of Weyl in a more readable manner was attempted. This discussion is given using a modern coordinate free approach. A complementary discussion of the modern theory of Lie algebras is also given. Total cross sections for a total of ninety-five events based on eight parameters are predicted. Only nineteen of these cross sections have been experimentally measured. Of these, seven consist of only one experimental measurement and so cannot be used. The remaining cases are sufficient only to show that the predictions seem to be of the correct order of magnitude. (Diss. Abstr. Int., B)

5799 NEW GAUGE IDENTITIES IN DUAL QUARK MODELS. Bardakci, K. (Univ. of California, Berkeley). Nucl. Phys.; B33: No. 2, 464-74(1971).

It is found that a simple dual quark model possesses a large number of gauge identities with a suitable choice of external particles. These identities eliminate a large number of undesirable states which usually plague relativistic quark models. (auth)

5800 MONTE CARLO SIMULATION ON PROPAGATION OF COSMIC-RAYS IN THE ATMOSPHERE. Fujimoto, Yoichi (Waseda Univ., Tokyo); Hasegawa, Shun-ichi; Kasahara, Katsuaki; (and others). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 246-70(1971).

A similation study is made on propagation and multiplication of cosmic-ray components in their passage through the atmosphere, which corresponds to observation of high-energy cosmic particles by the emulsion chamber exposed at mountain altitudes. The method of the similation calculation is first described together with basic assumptions made on the elementary process of multiple meson production and the electromagnetic phenomena. An outline of the calculated results is then given. (L.B.S.)

5801 APPLICATION OF THE BALAZS METHOD WITH A BRANCH CUT TO PION–PION SCATTERING. Gibbons, Thomas Charles Athens, Ohio; Ohio Univ. (1971). 165p. University Microfilms Order No. 71-29,524.

Thesis.

The purpose is to investigate the accuracy and stability of a modification of the Balázs method of calculating a partial wave amplitude, and to apply the same method to the problem of pion-pion scattering. A pion-pion partial wave amplitude contains a right hand branch cut in the physical region of the energy variable and also a left hand cut that is related to the "forces" involved in the process, as obtained from the crossed channel reaction. The Balázs method is a method of approximating this left hand cut by a series of poles. Certain mathematical difficulties which arise in the calculation of the cut from the crossed channel are thus avoided, but the approximate procedure introduces some instabilities and uncertainties into the results. This is true because the unknown pole parameters must be obtained by numerically matching the amplitude as obtained from the Balázs procedure with a form obtained from the crossed channel in the gap between the two cuts. It has been shown that the results are sensitive to the details of the matching process. However, the effects of the instabilities can be lessened if the pole approximation is used for only part of the left hand cut. It is possible to retain a portion of this cut and still avoid the mathematical troubles involved in obtaining it from the crossed channel, but the calculation becomes more complex and more difficult to carry out. The purpose is to study the stability and reliability of the Balázs method, as modified to retain part of the cut, and to apply it to pion-pion scattering. The accuracy and stability was studied by using the method to reproduce certain known functions. These functions were constructed to resemble an $1 = 1$ pion-pion partial wave. They satisfied elastic unitarity, the proper analyticity requirements, and the p-wave threshold condition, and in addition, they contained a resonance at approximately the mass of the ρ, which is the pion-pion $1 = 1$ resonance. They were reproduced in the physical region by the modified Balázs method from their known values on the part of the cut that is retained and in the gap. In the pion-pion calculations, the three partial waves that were obtained were the p-wave with $I = 1$ and the d-waves with $I = 0$ and $I = 2$. The first two of these were expected to contain the ρ and f^0 resonances, respectively, and the third was expected to be nonresonant. The necessary crossed channel input for these calculations consisted of five combinations of the four lowest lying pion-pion resonances. The results show that calculations with this method can be extremely accurate and reliable provided that sufficiently accurate estimates of the amplitude in the known regions are used and provided the pole positions are chosen to optimize the agreement between the two forms in the gap. This method of choosing the pole positions differs from the original method of Balázs. The need for accurate inputs shows that the crossed channel inputs must be treated carefully in the pion-pion problem, but the results of the pion-pion calculations show a progressive improvement with an increasing number of crossed channel partial waves. For the most accurate cases, the expected resonances are obtained in approximate agreement with experiment, and the nonresonant partial wave is also obtained in approximate agreement with some other recent estimates. (Diss. Abstr. Int., B)

Strong (Baryon No. = 0)

Refer also to abstract 5796 and 5849.

5802 DALITZ-PLOT ANALYSIS OF THE ANNIHILATION PROCESS $\bar{p}N \to 3\pi$ AT REST USING VENEZIANO-TYPE AMPLITUDES. Nicholas, L. E. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 2: No. 19, 969-74(6 Nov 1971).

An attempt is made to fit the Dalitz plot for the annihilation process $\bar{p}n \to 3\pi$ with a sum of four-point functions. The statistical errors on the coefficients are given for best fits. The ratios of the decay rates are tested for each case for $R(\bar{p}p \to 3\pi^0) : R(\bar{p}n \to \pi^+\pi^-\pi^-) : R(\bar{p}p \to \pi^+\pi^-\pi^0)$ and compared with experimental results for $R(\bar{p}p \to \pi^+\pi^-\pi^0)/R(\bar{p}n \to \pi^+\pi^-\pi^-)$. (L.B.S.)

5803 SOME CONSEQUENCES OF RESONANCE PRODUCTION ACCORDING TO THE SCALING HYPOTHESIS. Brink, L.; Cottingham, W. N.; Nussinov, S. (CERN, Geneva). Phys. Lett.; 37B: No. 2, 192-4(15 Nov 1971).

The scaling behavior of particles coming from decay of resonances is investigated. It is shown that resonance production can give some characteristic features in inclusive distributions. (auth)

5804 DISPERSION CALCULATION OF ISOSCALAR ELECTROMAGNETIC FORM FACTORS. Aubrecht II, Gordon J. Princeton, N. J.; Princeton Univ. (1971). 153p. University Microfilms Order No. 71-23,342.

Thesis.

Using dispersion theory and the assumption that the three-pion cut is well-represented by the rho-pi cut, the $I = 0$ $J = 1$ rho-pi and $K\bar{K}$ scattering amplitudes are calculated from a certain matrix integral equation using only right hand cuts. This is an effective range type approximation. Subtraction constants are determined by the experimental masses and widths of the isoscalar vector resonances. The model is found to have the property that there are no ghosts (spurious first sheet poles). The rho-pi and $K\bar{K}$ electromagnetic form factors are computed near the omega and phi masses and are compared with the available colliding beam data. The isoscalar charge radii are also computed. The agreement of the model with the experimental values is satisfactory. An estimate of 40 keV is obtained for the (so far unobserved) partial width of the decay $\rho^- \to \pi\gamma$. (Diss. Abstr. Int., B)

5805 BOOTSTRAP CALCULATION OF THE RHO RESONANCE. Williamson, Marlene Ann Richter. Medford, Mass.; Tufts Univ. (1971). 156p. University Microfilms Order No. 71-22,634.

Thesis.

A single channel inelastic bootstrap calculation of the rho resonance in pion–pion scattering is reported. The Frye–Warnock inelastic N/D method is used. The inelastic factor at low energy is determined by the $\pi\pi \to \pi\omega$ reaction. At high energy it is determined by the Regge pole asymptotic form. The near left hand cut is given by the analytic continuation of the cross channel partial wave expansion. The far left hand cut is approximated by poles introducing parameters which are fixed by requiring that the high energy amplitude conform to that predicted by Regge pole exchange. The calculated mass of the rho is in good agreement with experiment. However, the width is much too large. A double bootstrap of the rho and f_0 does not work. (Diss. Abstr. Int., B)

5806 EXPERIMENTAL TEST OF HARD-PION CURRENT ALGEBRA PREDICTIONS. Polito, Peter J. Boston; Northeastern Univ. (1971). 126p. University Microfilms Order No. 71-21,994.

Thesis.

Standard hard-pion current algebra techniques are extended to obtain predictions of decay widths for various decays of the A_1-meson and for colliding beam experiments with various hadronic

final states. A detailed investigation of these colliding beam experiments is suggested as a possible experimental test of the hard-pion current algebra predictions. Interference effects in the decay mode $A_1 \rightarrow \rho + \pi \rightarrow 3\pi$ are carefully analyzed. The procedure followed differs from the standard current algebra approaches in that pole dominance on the vector current propagator is not assumed, but some of the continuum contributions to the vector current propagator are included. In addition, alternative models for smoothness assumptions on the A–A–V vertex function are considered. (Diss. Abstr. Int., B)

5807 MASS-SPLITTING WITHIN MESONIC ISOSPIN MULTIPLETS. Fohlmeister, Jurgen Fritz. Minneapolis; Univ. of Minnesota (1971). 80p. University Microfilms Order No. 71-22,193.

Thesis.

Recent calculations have indicated that something more than the ρ-pole (VMD) is needed in hadronic electromagnetic interactions. A bare coupling is added and it is found that for the pion mass shift this is a sufficient generalization of field algebra to eliminate the need for subtractions and leads to a finite result for on-shell pions. This more general formulation is used to compare with and unify the calculations of Das, Guralnik, Mathur, Low and Young (1967) and Lee and Nieh (1968). Next the pion mass-shift problem is formulated within the Veneziano model. Using s-, u-channel duality (the t-channel is exotic) results are found closely correlated to those of an s-channel pole approximation and field algebra. Finally two formulations are proposed for the kaon mass-shift. The first is based on the possibility that the leading term in the asymptotic expansion for the forward kaon Compton amplitude is cancelled, allowing an s-channel pole approximation. The second allows an asymptotic behavior of $s^{\alpha_{Az}(t=0)} \pm s^{\frac{1}{2}}$ and is formulated within the Veneziano model. Vector meson dominance is employed in the first case and the strongly convergent version of the Oyanagi form factor in the second, leading to a finite mass-shift in both cases. The experimentally unresolved status of the K_A mass spectrum prohibits a definitive calculation of the kaon mass difference, but it is shown how the sign reversal may come about in both cases. (Diss. Abstr. Int., B)

5808 RADIUS OF CONVERGENCE FOR PERTURBATION EXPANSIONS IN THE SU_3 σ MODEL. Carruthers, P.; Haymaker, Richard W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 6, 1808-15(15 Sep 1971).

The dependence of tree-approximation solution of the Su_3 σ model for mesons on the $SU_3 \times SU_3$ symmetry-breaking parameters was investigated in detail. From the explicit relations of the model the existence of a radius of convergence of power series expansions about the symmetry limit is established. This radius of convergence is an order of magnitude smaller than the value determined by fitting the model to the pseudoscalar nonet masses. The mixing angles and scalar masses implied by the model are in surprisingly good agreement with (fragmentary) experimental data. Using the experimentally determined parameters, it is possible to compare the behavior of the several possible solutions in the limit of $SU_3 \times SU_3$ symmetry. Of these, only that having SU_3 symmetry of states and a pseudoscalar octet of massless Goldstone bosons is stable under symmetry-breaking perturbations. This result provides a dynamical reason for this frequently used assumption. The symmetry-breaking parameters turn out to be such that the Lagrangian has approximation $SU_2 \times SU_2$ symmetry. The physical point can be reached by first turning on either the SU_3-invariant or the $SU_2 \times SU_2$-invariant $SU_3 \times SU_3$ symmetry-breaking operators to their physical values and then using perturbation theory. In each case the perturbation expansion converges. (auth)

5809 FURTHER CONSTRAINTS ON THE $\pi^0\pi^0$ s-WAVE AMPLITUDE. Yen, H. C.; Roskies, R. (Yale Univ., New Haven). Phys. Rev., D; 4: No. 6, 1873-85(15 Sep 1971).

On the basis of positivity and crossing symmetry, further constraints on the $\pi^0\pi^0$ s wave are derived. One of these relates the physical region to the region below threshold, where crossing is easy to apply. It is sufficiently strong that none of the models of unitarized $\pi\pi$ partial waves examined satisfies it. Sufficient conditions which indicate that the results cannot be improved very much are derived. Finally, it is shown how the knowledge of the s wave below threshold can give useful information about the physical partial waves. (auth)

5810 SPONTANEOUS BREAKDOWN OF CONFORMAL AND CHIRAL INVARIANCE. Crewther, Rodney James. Pasadena, Calif.; California Inst. of Tech. (1971). 187p. University Microfilms Order No. 71-27,096.

Thesis.

The implications of a theory in which scale and chiral invariance are spontaneously broken, and the dilaton σ appears as a mixture of the two isoscalar members of the scalar nonet are discussed. From standard assumptions for the conformal properties of the axial-vector current, the ratio of the $\sigma\pi\pi$ and σNN coupling constants is predicted, and the hypothesis of f-dominance is tested. At first the effects of scale violation are neglected. Then, the calculated width of the dilaton, Γ_σ, appears to exceed the limit given by the Adler–Weisberger sum rule for $\pi\pi$ scattering, while f-dominance seems to work. Using the method of collinear dispersion relations, scale-breaking effects are estimated, which are found to be large. In the real world, the result for Γ_σ agrees with other expectations, both experimental and theoretical. However, the spin-2 gravitational radius of the pion is found to be double the prediction of f-dominance. This is consistent with experimental indications that f-dominance fails. Meson–baryon scattering and its relation to parameters measuring the breaking of chiral symmetry in the energy density is discussed. The interpretation of a recent result is that scale invariance is spontaneously broken, and chiral $SU(2) \times SU(2)$ is a much better symmetry than SU(3). By requiring consistency with a sum rule of von Hippel and Kim, it is found that data for πN scattering are not consistent with the dimension of the chiral-violating scalar being –1. (Diss. Abstr. Int., B)

Strong (Baryon No. = 1)

5811 (CONF-690217–(Ch.2), pp 24-37) APPLICATION OF DISPERSED CORRELATIONS TO PHASE ANALYSIS. Dyatlov, I. T. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Both forms of the dispersion method as applied to phase analysis have advantages and disadvantages, but neither can pretend to yield precise, single-valued choice of phase. A Mandel'shtamov surface is diagrammed and discussed. Dispersion relations for a specified imparted momentum t and for partial amplitudes are analyzed, with special reference to partial amplitudes of πN-scattering. (K.S.W.)

5812 (CONF-690217–(Ch.2), pp 38-92) INVESTIGATION OF RESCATTERING IN THE THEORY OF THE INTERACTION OF PARTICLES AT HIGH ENERGIES. Ter-Martirosyan, K. A. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Attention is focused on the determination of the amplitude of particle interactions at high energies by the contribution of Regge poles and the consequent scattering by them. Double Regge branching is analyzed by Feynman diagrams, using πd-scattering as an example. "Optical" formulas are considered in connection with multi-Regge terms, and re-scattering contribution for $\alpha^2 \leq M_N^2$ at ultra-high and high energies. The amplitudes of πN-scattering and NN-scattering allowing for spin are mathematically developed. The subject of "reinforced" graphs is compared with Regge graphs. The last section is devoted to amplitudes of ternary NN-rescattering. (K.S.W.)

5813 (CONF-690217–(Ch.2), pp 93-109) BREMSSTRAHLUNG OF HADRONS AND INTERFERENCE OF COULOMBIC AND NUCLEAR INTERACTION AT HIGH ENERGIES. Lipatov, L. N. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

A lecture devoted to the part played by electromagnetic processes in the interaction of hadrons is discussed. A detailed analysis of bremsstrahlung in the charge-exchange reaction $\pi^+ + n \rightarrow \pi^0 + p$, as well as interference of Coulomb and nuclear interactions accompanying elastic π^+p-scattering at small angles are given. The possibility of emission of several bremsstrahlung quanta is taken into consideration. The applicability of quasi-classical formulas for π^+p-scattering within the framework of the Regge model is discussed. (auth)

5814 (CONF-690217–(Ch. 2), pp 276-94) PHASE ANALYSIS OF πN-SCATTERING. Shchegel'skii, V. A. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

A review of new achievements in the analysis of experimental data on πN-scattering by the phase analysis method is presented. The problem of selecting the optimal number of parameters statistically necessary to describe the experiment is discussed. A critical analysis of the πN-scattering length determined previously for a reduced number of parameters, which led to an unjustifiably low value of the errors, is presented. A new analysis leads to the following values for the πN-scattering lengths: $a_{I,2J}$: $a_{30} = -0.097 \pm 0.010$ ($h = c = m_\pi = 1$), $a_{10} = 0.140 \pm 0.025$, $a_{33} = 0.209 \pm 0.034$, $a_{31} = 0.1$ (fixed), $a_{13} = 0.091 \pm 0.046$, $a_{11} = 0.029 \pm 0.041$. Errors

in determining the scattering length for the new analysis agree with the average experimental accuracy (approximately 10%) in the energy range of the primary pions ≤ 100 MeV. The constants of the πNN-bond $f^2 = 0.096 \pm 0.007$ and the position of (3/2, 3/2)-resonance $\omega^* = 2.221 \pm 0.069$ were determined simultaneously (ω^* is the total resonance energy in the center-of-mass system, considering proton mass). The πN-resonances were analyzed in the pion energy region 240 to 650 MeV by the phase analysis method on the SDS-1604 A computer. Two sets of solutions were found for the πN-phases for which a unique selection could not be made. The first solution for the phases and inelasticity parameters is characterized by a smooth relation between these quantities and energy, but as distinct from earlier solutions, none of the phases up to a pion energy of 650 MeV reaches 90°. Resonances in this case were sought by the Argand diagram method. A resonance was observed in the D_{13}-state with the ordinary characteristics. The large errors made it impossible to conclude the existence of resonance in the P_{11}-state. In the mass region of the πN-system $m_\pi N \leq 1550$ MeV, S_{11}-resonance was not observed with reliability. (auth)

5815 TRIPLE-REGGEON COUPLINGS AND THE REACTIONS $\pi^+ + p \rightarrow \pi^0 +$ ANYTHING. Mickens, R. E. (Fisk Univ., Nashville). Lett. Nuovo Cim.; 2: No. 20, 1060-2(13 Nov 1971).

Triple-Reggeon couplings are obtained from the double differential cross sections for the reactions $\pi^+ p \rightarrow \pi^0 +$ anything and $\pi^- p \rightarrow \pi^0 +$ anything near the kinematical boundaries. (L.B.S.)

5816 NONCONSERVATION OF s-CHANNEL HELICITY IN A_3 PRODUCTION AT 13 GeV/c. Paler, K.; Mulera, T. A.; Miller, D. H.; (and others) (Purdue Univ., Lafayette, Ind.). Lett. Nuovo Cim.; 2: No. 20, 1063-8(13 Nov 1971).

Evidence for nonconservation of s-channel helicity in diffractive A_3 production is obtained from a study of the angular distributions and density matrix elements for the reactions $\pi^+ d \rightarrow dA_3^+ \rightarrow d\pi^+\pi^+\pi^-$ and $\pi^+ p \rightarrow pA_3^+ \rightarrow p\pi^+\pi^+\pi^-$ at 13 GeV. (L.B.S.)

5817 DUAL STRUCTURE IN THE SCATTERING AMPLITUDE $\pi N \rightarrow \omega N$. Miyata, Y. (Tokyo Inst. of Tech.). Lett. Nuovo Cim.; 2: No. 19, 1005-8(6 Nov 1971).

The dual structures of the scattering amplitude for $\pi N \rightarrow \omega N$ are studied, and it is shown that the vector (tensor) coupling part of the direct-channel amplitude is dual with the tensor (vector) coupling part of the exchanged-channel amplitude. Relations among coupling constants for $\bar{N}N\pi$, $\omega p\pi$, and $\bar{N}N\omega(\rho)$ are also given. (L.B.S.)

5818 COMMENT ON LOW-ENERGY K^+p SCATTERING. Carreras, B. (Daresbury Nuclear Physics Lab., Eng.); Donnachie, A. Lett. Nuovo Cim.; 2: No. 20, 1028-30(13 Nov 1971).

Data on K^+p elastic scattering from 432 to 939 MeV/c are reanalyzed on the basis of energy-dependent phase shifts. The solution gives a consistent description of all experimental data and in particular, of the total cross section data, reproducing the dip at about 700 MeV/c. (L.B.S.)

5819 POISSON DISTRIBUTIONS AND DIFFRACTIVE SCATTERING. Rotelli, P. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 2: No. 20, 1037-41(13 Nov 1971).

The application of Poisson distribution to inelastic cross sections at high energies is discussed from the viewpoint that the elastic data should be excluded. The remaining problem of diffractive contributions to the inelastic cross sections is considered. The diffractive contributions for pp and π^-p scattering are estimated from experiment. (L.B.S.)

5820 STATISTICAL WEIGHT CALCULATIONS FOR K^+p INTERACTIONS USING THE SU(3) GROUP. Teleman, Mihaela Compt. Rend., Ser. B; 273: No. 8, 321-4(23 Aug 1971). (In French).

A statistical weight calculation is presented for K^+p interactions with three particles in the final state (one nucleon and two mesons). The statistical model, involving the SU(3) group invariance instead of the isotopic invariance, is used. It is thus possible to obtain directly the statistical weights of final states with n particles belonging to given irreducible representations of the SU(3) group. (France)

5821 ELASTIC $\Sigma^\pm p$ SCATTERING AT LOW ENERGIES. Eisele, F.; Filthuth, H.; Foehlisch, W.; Hepp, V.; Zech, G. (Univ., Heidelberg). Phys. Lett.; 37B: No. 2, 204-6(15 Nov 1971).

Total and differential elastic $\Sigma^\pm p$ scattering cross sections were measured in the momentum interval of 130 to 180 MeV/c. From the $\Sigma^\pm p$ total cross section allowed regions for the singlet and triplet scattering lengths are derived, applying the effective range approximation. (auth)

5822 DETERMINATION OF PION–NUCLEON COUPLING CONSTANT BY ANALYTIC EXTRAPOLATION. Lichard, P. (SVST, Bratislava, Yugoslavia); Presnajder, P. Nucl. Phys.; B33: No. 2, 605-13(1971).

Extrapolating analytically the data on the forward pion–nucleon scattering amplitude $f^2 = 0.0803 \pm 0.0010$ is found. The error means, in contradistinction to previous calculations, one standard deviation and is precisely and unambiguously defined. The method naturally supresses the inaccurate data and contributions from regions where the data are rare. The result is thus insensitive to the detailed shape of the amplitude in the region immediately above the threshold. In previous calculations the data (or indirect evidence) in this region played a major role in the determination of f^2. The effect of hypotheses about the high energy behavior of scattering amplitude is also suppressed. (auth)

5823 REGGE CUTS AND πN CHARGE-EXCHANGE TO POLARISATION. Coleman, J. W.; Johnson, R. C. (Univ. of Durham, Eng.). Nucl. Phys.; B33: No. 2, 614-20(1971).

The process $\pi^-p \rightarrow \pi^0n$ at high energy is described by exchange of the ρ-pole plus $\rho \otimes P$ cut. Models with and without nonsense zeros are considered, the latter finding it easier to explain new polarization measurements at 5 and 8 GeV/c. (auth)

5824 DUAL APPROACH TO REGGE DIPS. Gell, Y. (Tel Aviv Univ., Israel); Horn, D.; Jacob, M.; Weyers, J. Nucl. Phys.; B33: No. 2, 379-96(1971).

The analysis of πN charge exchange suggests that some prominent features associated with Regge dips are also properties of each of the leading peripheral resonances, duality holding in an almost local sense. The use of local duality, together with a simple Regge prescription for the dips leads, however, to very strong restrictions for more complicated spin structures. As a test case πΔ charge exchange is studied and it is shown how such constraints could still work and produce a nonsense zero. The equivalence between the t-channel Regge pole and s-channel absorptive description of the dip structure is, however, lost. A different s-channel description emerges and leads to a strong prediction for two step decays of higher resonances. A qualitative discussion of a few other reactions is briefly presented. (auth)

5825 SIMPLE EMPIRICAL DESCRIPTION OF $K^{\pm}p$ ELASTIC SCATTERING COMBINING REGGE AND ABSORPTION MODELS. Cline, D.; Matos, J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nucl. Phys.; B33: No. 2, 421-35(1971).

The sums and differences of K^+p and K^-p elastic scattering angular distributions above 3 GeV/c incident momentum are analyzed. A simple factorization model, in which the t dependence and s dependence of the amplitudes are separated, is utilized to obtain a simple empirical description of these cross section combinations. Conventional values for the Pomeranchuk and ω trajectories are obtained. The Pomeranchuk and ω residue functions are quantitatively well described by a single exponential and the Bessel function J_0, respectively. Additional crossovers of the K^+p and K^-p elastic cross sections are predicted at $t = -1.1$, -2.7 and -5.0 $(GeV/c)^2$. (auth)

5826 INELASTIC EFFECTS AND π–N RESONANCES. Aaron, R. (Los Alamos Scientific Lab., N. Mex. Northeastern Univ., Boston); Amado, R. D. Phys. Rev. Lett.; 27: No. 19, 1316-19(8 Nov 1971).

Inelastic effects (ρ production, Δ production) and particle-exchange effects are shown to determine the major features of the π–N D_{13}, D_{33}, and P_{13} waves. The $D_{33}(1670)$ is associated with a resonance pole, but the $P_{13}(1860)$ is not. (auth)

5827 RECENT WORK AT SLAC ON THE STRUCTURE OF THE PROTON. Panofsky, W. K. H. (Stanford Univ., Calif.). J. Franklin Inst.; 292: No. 2, 73-6(Aug 1971).

Research at SLAC on the proton structure is described in which an electron beam from an accelerator impinges on a liquid hydrogen or deuterium target, and the scattered electron energies are analyzed with a magnetic spectrometer. Thus it is found that the proton has a structure and energy levels. (J.F.P.)

5828 UNITARY SYMMETRY AND DUALITY IN THE SCATTERING OF HADRONS. Roy, T.; Chowdhury, A. Roy (Jadavpur Univ., Calcutta). Phys. Rev., D; 4: No. 6, 1916-17(15 Sep 1971).

A previously suggested method for suppression of exotic resonances in meson–meson scattering is extended to the case of the meson–baryon interaction. The diagonalizing matrix S is identified as one of the crossing matrices itself; this is also seen to be essential for the reproduction of the correct signature of the t-channel trajectories. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 5962, 5963, and 6146.

5829 (IFVE-STF-70-75) STRUCTURE OF THE SCATTERING AMPLITUDE AND INELASTIC PROCESS AMPLITUDES IN PREASYMPTOTIC REGION. Anisovich, V. V.; Kistenev, E. P.; Kobrinskii, M. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of the energy level when the asymptotic behavior appears is studied for the example of the Regge pole model. It was shown that asymptotics in the angular distributions of the scattering processes (the dependence exp (βt lns)) may appear only at considerably large energies: in NN-scattering at $E_{lab} \gg$ 100 GeV, in πN-scattering at $E_{lab} \gg$ 20 GeV. Attention is paid to the fact that the diffraction peak observed in scattering processes at large energies appears at considerably low energies at P_{lab} = 1 to 2 GeV/c. The structure of the total cross sections at P_{lab} = 1 to 5 GeV/c was considered in detail so as to clarify the nature of this diffraction. (auth)

5830 NOTE ON THE SCALING LAW AND ITS TEST BY THE RECENT I.S.R. EXPERIMENT. Narayan, D. S. (Tata Inst. of Fundamental Research, Colaba, India). Lett. Nuovo Cim.; 2: No. 19, 975-8(6 Nov 1971).

It was reported in a previous study of inclusive cross sections using CERN intersecting storage rings (Phys. Rev. Lett., 27: 68 (1971)) that for pions in the kinematical range x = 0.1 to 0.3, the cross sections appear to obey the scaling law, while for protons the cross sections decrease at small x for increasing incident energy. It is shown that the validity of the scaling law for pions in this range can be understood in terms of the formation of baryon isobars and their subsequent decay. (L.B.S.)

5831 DECK EFFECT IN INCLUSIVE REACTIONS. Marchesini, G. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 2: No. 19, 985-91(6 Nov 1971).

It is suggested that various features of the pion distribution near the kinematics boundary in the reaction $p + p \rightarrow \pi^{\pm}$ + anything may be explained in terms of the Deck effect. The reaction is assumed to proceed via peripheral excitation of two protons in two N* states. The contributions from the limiting or scaling part of the pion distribution for limited masses of N*'s are examined. (L.B.S.)

5832 SPIN INDEPENDENCE IN NUCLEON-NUCLEON SCATTERING. Muller, H. J. W.; Stocker, D. (Ludwig-Maximilians-Univ., Munich). Lett. Nuovo Cim.; 2: No. 20, 1031-6 (13 Nov 1971).

It is shown that, for NN scattering and in the extreme high-energy limit, s-channel helicity conservation and spin independence are indistinguishable if the latter is understood in the sense that T-matrix elements which are diagonal in the z-component of total spin dominate over off-diagonal elements at high energies. In particular, it is shown that the assumption of spin independence leads to the well-known factorization property of residues of amplitudes to which the pomeron can be coupled. (L.B.S.)

5833 EXAMINATION OF PARITY NONCONSERVATION BY MEANS OF RADIATIVE NEUTRON-DEUTERON CAPTURE. Hadjimichael, E.; Harms, Edward; Newton, Victor (Fairfield Univ., Conn.). Phys. Rev. Lett.; 27: No. 19, 1322-5(8 Nov 1971).

Results for the circular polarization of photons emitted in the reaction $n + d \rightarrow {}^3H + \gamma$ arising from parity nonconservation in the weak nucleon-nucleon interaction are reported. Polarizations are found to be of the order 10^{-6}. (auth)

5834 RELATIVISTIC EFFECTS IN LOW-ENERGY NUCLEON-NUCLEON SCATTERING. Fortes, M. (State Univ. of New York, Stony Brook. Niels Bohr Inst., Copenhagen); Jackson, A. D. $_{14}$Nucl. Phys.; A175: No. 3, 449-61(1971).

The Bethe-Salpeter equation is solved in the ladder approximation by using a Wick-rotated kernel to obtain s-wave phase shifts in the elastic scattering region. These are obtained for superpositions of one-boson-exchange potentials suggested by a nonrelativistic, phenomenological analysis of nucleon-nucleon scattering data, and the relevance of such relativistic calculations to low-energy nuclear physics is discussed. A comparison between Bethe-Salpeter phase shifts and Lippmann-Schwinger results is made, and the validity of the Blankenbecler-Sugar approximation to the Bethe-Salpeter equation is discussed. (auth)

5835 PION PRODUCTION. Gugelot, P. C. (Univ. of Chicago). pp 404-15 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Some attempts at a theoretical description of pion production processes are briefly reviewed. An attempt is made to calculate the pion production cross section according to a simple model. The basic idea is the use of available pion-nucleon scattering amplitudes and an NπN vertex function for the virtual emission of the pion. The model is demonstrated for the case of π^0 emission from pp inelastic scattering. (L.B.S.)

5836 $\pi\pi$ SCATTERING EFFECTS IN π-DEUTERON ELASTIC SCATTERING. Vickson, R. G. (Univ. of British Columbia, Vancouver). pp 423-8 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The scattering of pions directly off the nuclear pion cloud rather than off the individual target nucleons is discussed. The effects of $\pi\pi$ scattering in comparison with the multiple scattering are examined for the case of very low-energy πd elastic scattering. (L.B.S.)

5837 COLLAPSED NUCLEI. Bodmer, A. R. (Nuclear Physics Lab., Oxford. Argonne National Lab., Ill. Univ. of Illinois, Chicago). Phys. Rev., D; 4: No. 6, 1601-6(15 Sep 1971).

The observational consistency, possible properties, and detection of collapsed nuclei C_A are discussed. These may be considered as elementary particles with mass number A > 1 and of much smaller radius than ordinary nuclei N_A. The existence of C_A of (perhaps much) lower energy than N_A is observationally consistent if N_A are very long-lived isomers against collapse because of a "saturation" barrier between C_A and N_A. Barrier-penetrability estimates show that sufficiently long lifetimes $\geq 10^{31}$ sec are plausible for $A \gtrsim 16-40$. The properties of C_A are discussed using composite baryon and quark models; small charges and hypercharges and, especially, neutral C_A are possible. C_A can be effectively a source or sink of baryons. Some astrophysical implications are briefly discussed, in particular the possible large scale presence of C_A and the possibility that accelerated collapse in massive objects may be a source of energy comparable to the rest mass. (auth)

5838 ROLE OF HADRON STRUCTURE IN STRONG ELASTIC AND INELASTIC SCATTERING. Benofy, Leslie Peter. Seattle; Univ. of Washington (1971). 97p. University Microfilms Order No. 71-27,317.

Thesis.

A model is presented which in the context of a subparticle picture for the hadrons explicitly indicates the role of hadron structure in strong diffractive scattering at very high energies and small angles. In elastic scattering to lowest order the model reproduces the Wu-Yang conjecture if one assumes that the single-subparticle distribution in a hadron is the same in strong scattering as that seen when the hadron is observed using weak probes such as electrons. The multiple scattering corrections obtained in higher orders are expressed in terms of the many-subparticle distribution functions of the hadrons involved. The manner in which the many-subparticle distribution functions seen in strong and electron scattering should be related is explicitly indicated for the two-subparticle distribution case. This generalized Wu-Yang relation leads in lowest order to an interesting consistency relation among electron-hadron and hadron-hadron elastic and inelastic scattering. The model is applied to proton-proton (pp) and proton-deuteron (pd) scattering. The main results are: a detailed fit to pp elastic differential cross section data yielding the first evidence for the consistency of the nonrelativistic SU_3-quark model with momentum-transfer-dependent data; the inelastic data suggest that correlations exist among the constituents of the proton and that $F_2(\omega)$, one of the inelastic electromagnetic form factors of the proton, vanishes as $\omega \rightarrow \infty$; and a new expression for the "shadow" correction to the total pd cross section which takes into account nucleon structure and inelasticity. (Diss. Abstr. Int., B)

5839 PION-NUCLEUS SCATTERING LENGTHS AND SIGMA COMMUTATOR. Huang, Wen-tseh College Park, Md.; Univ. of Maryland (1971). 96p. University Microfilms Order No. 71-29,702.

Thesis.

Pion-nucleus scattering lengths are compared with soft pion predictions modified by the corrections given by the Fubini, Furlan mass dispersion relation. Good agreement is found for the known scattering lengths which presently correspond to $1 \leq A \leq 23$, where A is the target mass number. In evaluating the soft pion limits it is assumed that the sigma commutator contribution is proportional to A with a slope fixed by the nucleon data. It is also shown that in the approach the effect of Fermi motion is small. (Diss. Abstr. Int., B)

5840 LOW ENERGY BARYON-BARYON SCATTERING IN THE TRIPLET STATE. Curiale, John Samuel New Haven; Yale Univ. (1971). 88p. University Microfilms Order No. 71-28,155.

Thesis.

A potential model is used to study the low-energy behavior of the two-baryon system in the $J^P = (1)^+$ state. The potential is constructed from the sum of Yukawa potentials due to the exchange of low-lying pseudoscalar and vector meson octets. The coupling constants are fixed by SU(3) symmetry. The baryon pairs considered belong to the $\overline{1}0$ and 8a representations of SU(3). In addition to the meson exchange interaction a hard core interaction in both $\overline{1}0$ and 8a states with different radii is considered. The radius of the hard core for the $\overline{1}0$ representation is fixed by fitting the triplet NN scattering length. Several values of the hard core for the 8a representations are used. They yield values for the Λp-scattering length that are within the experimental range. A singularity is found in the Λp scattering amplitude. Using the ansatz that SU(3) is broken only by the difference of the meson and baryon masses from their degenerate values, the motion of this singularity is studied as a function of an SU(3) symmetry breaking parameter. In this way, it is found that the pole in the Λp amplitude which corresponds to the deuteron in the NN amplitude appears as a resonance just below the Σ N threshold. (Diss. Abstr. Int., B)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 5861.

5841 SPINORIALITY GROUPS. Crumeyrolle, A. (Univ., Toulouse). Ann. Inst. Henri Poincare, Sect. A; 14: No. 4, 309-23(1971). (In French).

The definitions and properties of trivial spinorial structures are recalled and the idea of a trivial canonical spinorial structure is deduced from them. The idea of spinoriality group is then introduced and some of its properties are established. (France)

5842 GROUP THEORETICAL MODEL FOR MASS-SPLITTING. Westenholz, C. V. (Univ., Muenster, Ger.). Ann. Inst. Henri Poincare, Sect. A; 14: No. 4, 295-308(1971).

The extensions of the orthochronous inhomogeneous Lorentz group with determinant +1 by some internal symmetry group G_I are considered and a new quantal observable, called the symmetry breaking operator C(f) which measures the mass splitting of particles within some multiplet, is introduced. A model is proposed for the mechanism of the symmetry breaking experimentally observed. This model reveals the existence of nontrivial couplings between space-time symmetry and some internal symmetry. (France)

5843 SCALING BEHAVIOR OF CURRENTS. Katz, J. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 6, 1885-7(15 Sep 1971).

Necessary and sufficient conditions in order for all components of a local operator (such as a current, for example) to have the same dimension are given and discussed. In addition, it is then noted that exact scale invariance is in an apparent formal contradiction with a definite scaling behavior for the currents. The solution of this contradiction is then traced back to the fact that in scale-invariant theories, the Schwinger term must be quadratically divergent. Coleman's theorem for scale and conformal transformations is briefly discussed. (auth)

5844 DUALITY AND THE LORENTZ GROUP. Bars, Itzhak; Guersey, Feza (Yale Univ., New Haven). Phys. Rev., D; 4: No. 6, 1769-76(15 Sep 1971).

The suggestion that the internal SL(2,C) invariance of the generalized Virasoro model is in fact related to the same SL (2,C) group which generates Lorentz transformations on the external momenta is investigated. Fields are used which transform according to the representations of the homogeneous Lorentz group and the n-point Virasoro model is derived. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 5787.

5845 TESTS OF T INVARIANCE IN $e^+e^- \rightleftharpoons p\bar{p}$ AND T AND TCP REQUIREMENTS ON REACTIONS OF THE TYPE $a\bar{a} \rightleftharpoons b\bar{b}$. Hey, A. J. G. (California Inst. of Tech., Pasadena); Kabir, P. K. Lett. Nuovo Cim.; 2: No. 19, 1011-15(6 Nov 1971).

It is pointed out that the development of storage rings which permit the study of electron–positron annihilation at high energy opens the possibility of testing T invariance of the electromagnetic interaction of hadrons through comparison of the reaction $e^+ + e^- \rightarrow p + \bar{p}$ and its inverse $p + \bar{p} \rightarrow e^+ + e^-$. It is shown that while detailed balance in such reactions is assured by the assumption of TCP invariance alone, measurements of the spin dependence can be used to examine the hypotheses of T invariance and TCP invariance separately. (L.B.S.)

5846 POSSIBILITY OF TESTING C CONSERVATION IN THE POSITRONIUM THREE-PHOTON DECAY MODE. Del Fabbro, R.; Matone, G.; Satta, L. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 2: No. 8, 402-4(21 Aug 1971).

A method is found for testing charge conjugation conservation in positronium three-photon decay. It is presumed that the method may lower the present experimental limit of C violation in this decay by several orders of magnitude. (J.F.P.)

5847 PRESENT STATUS OF TIME-REVERSAL INVARIANCE. Richter, A. (Argonne National Lab., Ill.). pp 343-58 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Experimental tests of time-reversal invariance in strong, weak, and electromagnetic interactions are summarized. The present status of these experiments and some possibilities for improving them are examined. Experiments using the new medium-energy accelerators are mentioned. 55 references. (L.B.S.)

5848 DIMENSION OF SCALE-INVARIANCE-BREAKING INTERACTIONS. Levin, D. N.; Okubo, S.; Palmer, D. R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 6, 1847-50(15 Sep 1971).

Assuming the hadronic energy density has the decomposition $\Theta_{00} = \overline{\Theta}_{00} + \delta + u$ (where $\overline{\Theta}_{00}$ is chiral- and scale-invariant, δ is chiral-invariant but violates scale invariance, and u violates both chiral and scale invariance), rigorous bounds on the dimensions of δ and u in the (actual) SU(2)-symmetric limit and in the SU(3)-symmetric limit are found. If we further assume that δ is a c number, a new sum rule is derived which leads to satisfactory bounds on the dimension of u in the SU(2)-symmetric limit but not in the SU(3)-symmetric limit. Saturation of this sum rule with a scalar meson having a mass of 700 MeV leads to a value of 1.9 for the dimension of u. (auth)

Applications (Strong)

Refer also to abstracts 5808 and 5833.

5849 NONLINEAR REALIZATIONS OF SU(3) x SU(3) AND THE SYMMETRY-BREAKING MESON LAGRANGIAN. Rosen, S. P.; McDonald, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 6, 1833-46(15 Sep 1971).

It is shown how an octet of pseudoscalar mesons which transform nonlinearly under SU(3) × SU(3) can be converted to the linear realizations $(3,\bar{3})$ and $(\bar{3},3)$. The results are manifestly covariant with respect to redefinitions of the meson field. An effective meson Lagrangian is constructed in which all the symmetry breaking occurs in the mass term and belongs to a single representation $\{(p,\bar{p}) + (\bar{p},p)\}$. From an analysis of $\pi-\pi$ scattering lengths, it is found unlikely that the symmetry-breaking interaction belongs either to the self-adjoint sequence (8,8), (27, 27),..., or to the triangular one p = 6, 10, 15, ... There are, however, many other representations, including $\{(3,\bar{3}) + (\bar{3},3)\}$, which cannot be ruled out. Weak currents are also examined and it is found that the f_- form factor in K_{l3} decay gives rise to a serious problem in the symmetry breaking. (auth)

Field Theories

Quantum Field Theory

Refer also to abstract 5696.

5850 (ITEF–823) CONSERVATION OF AXIAL-VECTOR CURRENT IN MASSLESS ELECTRODYNAMICS. Dolgov, A. D.; Zakharov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 24p. Dep. NTIS (U. S. Sales Only).

Conservation of axial current in massless electrodynamics is considered in connection with the appearance of the so called anomaly in equation for divergence of axial current discussed recently. It is shown that transitions forbidden by γ_5-invariance give finite contribution to the imaginary part of the triangle graph in the limit of vanishing of the electron mass m. This phenomenon is analogous in some respect to the nonvanishing of probability of the transition between right- and left-polarised electron through photon emission discussed by Lee and Nauenberg. The breaking

of the relation $\partial_\mu j_\gamma^5 = 0$ for triangle graph is related to the breaking of the γ_5-invariance in the imaginary part of the graph. In this sense the appearance of the ultraviolate divergence in the triangle graph is irrelevant to the breaking of the γ_5-invariance. Some examples of the well convergent graphs and tree graphs which nevertheless violate conservation of axial current for some particular configuration of external momenta are given. Also another limiting procedure when m is chosen to be equal to zero from the very beginning but the photon mass is chosen finite is considered. Then it is possible to construct conserving axial current but matrix element is singular in photon mass. In the case of $m \neq 0$ a recipe to calculate the triangle graph is given which implies the validity of divergence condition $\partial_\mu j_\mu^5 = 2imj^5$ without any anomalous terms. The matrix element of pseudoscalar density j^5 is singular in m in this case however. (auth)

5851 (ORO-3992-23) FINITE QUANTUM FIELD THEORIES. Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). Sep 1971. Contract AT(40-1)-3992. 25p. (CONF-710635-1; CPT-122). Dep. NTIS.

From Symposium on basic questions in elementary particle physics; Munich, Germany (8 Jun 1971).

Three different alternate methods were suggested previously for avoiding the divergences characteristic of local interactions of quantized fields. These are the use of nonlocal interactions, the use of analytic manipulations on the coupled equations for amplitudes derived from the field theory, and the use of an indefinite metric space on which the operators are defined. These methods are briefly discussed, and an attempt is made to show that they are all essentially equivalent, but that the last method shows the altered framework most clearly. (J.F.P.)

5852 REGULARIZATION OF QUANTUM ELECTRODYNAMICS INDUCED BY NONPOLYNOMIAL LAGRANGIANS. Fanchiotti, H.; Garcia Canal, C. A.; Girotti, H. O.; Vucetich, H. (Univ. Nacional, La Plata). Lett. Nuovo Cim.; 2: No. 19, 1001-4(6 Nov 1971).

An analysis is made of the coupling of real massless scalar field with the interacting Dirac–Maxwell fields through a nonpolynomial factor $\sqrt{-g}$. Proof is given that such a superpropagator does not appear and, as a consequence, the removal of infinities does not follow from the nonpolynomial character of the Lagrangian. The suggestion is implied that if gravity plays a regularizing role in the theory, either its tensor character is essential for that purpose or the regularization is provided by other coupling. (L.B.S.)

5853 MASS SPECTRA OF SOME NONLINEAR WAVE EQUATIONS. Chew, H. (Clarkson Coll., Potsdam, N. Y.). Lett. Nuovo Cim.; 2: No. 20, 1025-7(13 Nov 1971).

The c-number prototype of a general class of Klein–Gordon field equation with self-interaction is considered, and particular solutions are obtained using elementary methods in nonlinear mechanics. The solution may be interpreted as excitations with a mass spectrum, which is computed explicitly for the ϕ^4 case. (L.B.S.)

5854 KATO PERTURBATIONS AND A CLASS OF MODELS. Tirapegui, E. (Princeton Univ., N. J. Rutgers–The State Univ., New Brunswick, N. J.). Lett. Nuovo Cim.; 2: No. 19, 1015-20 (6 Nov 1971).

Kato perturbation techniques are used to prove that the Hamiltonians in a class of zero-dimensional models are essentially self-adjoint under certain conditions. The theorem of Kato is also used to prove analyticity in the coupling constant. (L.B.S.)

5855 FIELD THEORETIC APPROACH TO THE YUKAWA INTERACTION OF SCALAR NUCLEONS IN THE ABSENCE OF ANTINUCLEONS. Schroeck, Franklin Emmett Jr. Rochester, N. Y.; Univ. of Rochester (1971). 352p. University Microfilms Order No. 71-22,318.

Thesis.

A simple model of quantum field theory is treated in a mathematically rigorous manner which is closer to the Hilbert space techniques known to most physicists than are the manipulations on the operator-valued field distributions of the Wightman formalism. This work is carried out in a generalization of the formalism of J. M. Cook in which the fields are bona-fide linear operators in Fock space, a Hilbert space. Functional analysis on Hilbert space provides the necessary mathematical tools. The model treats scalar nucleons interacting via the exchange of massive scalar mesons. This leads to the Yukawa interaction between the nucleons. For simplicity, the anti-nucleons are not included in the model. Scattering is investigated by proving the existence of the interpolating fields. It is found that for several classes of cut-off, the interpolating meson fields exist as strong limits as time $\to \pm \infty$, and retaining the cut-offs. For a smaller class of cut-offs and for recoiling fermions, the interpolating fermion fields also exist as strong limits in time. In the latter cases, algebraic considerations indicate that there is no interaction even if one of them removes the cut-off from these interpolating fields. For recoilless fermions, the interpolating fermion fields exist only as weak limits due to the wave-function renormalization present in this case. Also, in the recoilless fermion case, it is found that the cut-off may be removed before making the asymptotic time connection for the interpolating meson fields. In this (recoilless) case, the mesons do not scatter. (Diss. Abstr. Int., B)

5856 GALILEAN-COVARIANT FIELD EQUATIONS FOR PARTICLES WITH ARBITRARY SPIN. Hurley, William Jordan. Rochester, N. Y.; Univ. of Rochester (1970). 104p. University Microfilms Order No. 71-22,297.

Thesis.

Despite thirty-five years of work there is still no satisfactory relativistic wave equation for interacting particles with spin greater than one. Motivated by this classical difficulty in relativistic quantum mechanics, the analogous problem is examined within the framework of Galilean-invariant (nonrelativistic) quantum theory. After a brief review of the Galilean group and its projective representations some of the implications of this symmetry for quantum field theory are discussed and the Galilean analog of the Schwinger–Dirac covariance condition is derived. Wave equations which are Galilean-covariant and which describe massive particles with arbitrary spin are derived by assuming a Galilean-invariant Lagrangian and the use of only the fewest number of components necessary. The spin-0 case (Schrödinger equation) is found to be exceptional and it is shown that in its first order form the minimality condition must be violated. The Galilean analog of the Kemmer equation emerges. The general equations yield the previously found results for spin-$\frac{1}{2}$ and spin-1 as special cases. Some properties of the general spin equations are discussed. The external field interaction is introduced into the equations and, unlike the relativistic case, a completely uniform and consistent theory emerges. The particles possess only an electric monopole and magnetic dipole interaction thus confirming an argument of Levy–Leblond to this effect based on dimensional analysis. The magnetic dipole g-factor is found to be $g(s) = (1/s)$ for the "minimal" theory thus simplifying and completing the previous determinations of this factor which introduce the external field into the relativistic equations (when they are available) and then proceed to the result by taking the nonrelativistic limit. Theories which violate the minimality assumption are considered and, similarly to the relativistic case, they are found to have different electromagnetic properties. Whereas the minimal, $6s + 1$ theory yields a $g(s) = (1/s)$, a theory with $8s + 4$ components is given which has $g(s) = 0$ and finally a $12s + 4$ component theory with an arbitrary g-factor is displayed. The results of the present formalism are compared with some of the inconsistencies of the relativistic case. All inconsistencies vanish in the Galilean limit. It is suggested that the reason for this lies in the dimensional considerations discussed above. As the spin increases, elementary relativistic particles become more and more complex whereas elementary Galilean particles do not. Finally, the spin formalism is applied to the Galilean-invariant Lee model and find a generalization of this model whose solution yields results which differ greatly from those of the spinless case. (Diss. Abstr. Int., B)

5857 FIVE-DIMENSIONAL RELATIVITY. Ionescu-Pallas, N.; Hafner, H. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 6, 623-36(1971). (In Rumanian).

The five dimensional kinematics and dynamics are built-up from a new standpoint which assigns a greater degree of reality to the fifth coordinate. The 5th coordinate is assumed to be time-like. The electrodynamics is framed into this scheme via a variational principle acting in the 5-dimensional space. After the imposition of the charge preservation the field and the motion equations may be derived from a 4-dimensional variational principle. The effect of the 5th coordinate is to produce a certain additional scalar field. All the theory becomes Lorentz-invariant. Finally, the scalar wave equation coming from this theory is solved in the case of a point-like particle which evolves in an electric field produced by a point-like nucleus. (auth)

5858 DISPERSION THEORY OF THE LAMB SHIFT. McEnnan, James Judd. Gainesville, Fla.; Univ. of Florida (1970). 58p. University Microfilms Order No. 71-24,436.

Thesis.

The Lamb shift in hydrogen is calculated by means of dispersion theory. Relativistic covariance is maintained throughout the calculation and electron spin is included, although the spin of the proton is neglected. Divergence problems encountered previously were eliminated through exploitation of the Regge behavior of the

amplitudes which appear in the dispersion integrals. The result is in good agreement with the lowest order perturbation theory value. (Diss. Abstr. Int., B)

5859 WARD IDENTITIES AND CHARGE RENORMALIZATION OF THE YANG–MILLS FIELD. Taylor, J. C. (Oxford Univ.). Nucl. Phys.; B33: No. 2, 436-44(1971).

A generalized Ward–Takahashi identity is derived for the massless Yang–Mills field, which implies that Z_1/Z_2 has a common value for the vector field and for the "fictitious" scalar field, thus ensuring that the renormalized charges are equal. The identity may also be used to avoid ambiguities in working with quadratically divergent integrals. (auth)

5860 DEVELOPMENT OF QUANTUM FIELD THEORY. Segal, I. (Massachusetts Inst. of Tech., Cambridge). Fields Quanta; 2: No. 1, 51-91(Sep 1971).

Recent developments in the foundations of quantum field theory are reviewed. The topics discussed include the abstract algebraic approach, the mathematical development of the wave-particle duality, hyperbolicity of quantized partial differential equations, the meaning of nonlinear equations of motion and the interaction Hamiltonian as a generalized operator in a Hilbert space. In this last context the problems which arise if one requires the interaction Hamiltonian to be defined at a sharp time are discussed. It is emphasized that although this can be done in lower-dimensional space-time, a modification is likely to be required in four-dimensional space-time. Examples of such "distribution" propagators which allow a well-defined interaction representation are given. (auth)

5861 SYMMETRY BREAKING AND EFFECTIVE LAGRANGIANS. Banks, Thomas (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 6, 1927-8(15 Sep 1971).

It is shown that the Green's functions of a field theory may transform covariantly under a symmetry group even though the symmetry is broken. This is a generalization of a result derived by Aviv, Hari Dass, and Sawyer for the neutral σ model. The demonstration is carried out using the formalism of effective Lagrangians. (auth)

5862 DIVERGENCES OF MASSIVE YANG–MILLS THEORIES: HIGHER GROUPS. Glashow, S. L.; Iliopoulos, J.; Yao, Andrew (CNRS, Marseille). Phys. Rev., D; 4: No. 6, 1918-19(15 Sep 1971).

A previous analysis is extended to massive Yang–Mills theories based on semisimple groups other than SO(3). The multiplet of vector mesons may have arbitrary Yukawa couplings to fermions. It is shown that the naive degree of divergence of any Feynman amplitude is no worse than for the same theory without the meson self-couplings; the worst divergences are like $(g\Lambda)^{2n}$. (auth)

5863 CANONICAL APPROACH TO HIGH-ENERGY SCATTERING IN MASSIVE QUANTUM ELECTRODYNAMICS. Chang, Lay-nam (Univ. of Chicago); Chang, Ngee-pong. Phys. Rev., D; 4: No. 6, 1856-65(15 Sep 1971).

By the canonical Hamiltonian approach to field theory, the very high-energy limit of massive quantum electrodynamics is studied. A series of canonical transformations is introduced which bring the usual Hamiltonian of a neutral-vector-meson interaction with a conserved current to the effective Hamiltonian that operates at infinite energy. The result obtained for the S-matrix operator is that it factorizes at very high energies. (auth)

5864 MATCHING EXPLICIT AND SPONTANEOUS SCALE-INVARIANCE BREAKING IN LAGRANGIAN MODELS. Carruthers, P.; Haymaker, Richard W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 6, 1815-26(15 Sep 1971).

Effective Lagrangian models, constructed from fields transforming as $(3,\bar{3}) + (\bar{3},3)$ and (1,1) in $SU_3 \times SU_3$, are studied in the tree approximation to learn how solutions having broken scale and chiral symmetries are related to underlying limit solutions exhibiting spontaneous breakdown of these symmetries. The requirement of a smooth transition to the limit of scale invariance leads to restrictive conditions on the structure of the model and its solutions. For a special case of the general model, it is possible to compute explicitly the squared masses of the single-particle excitations in terms of symmetry-breaking parameters. The condition of stability ($m^2 \geq 0$) leads to the allowed domains of Okubo and Mathur, and hence, provides a physical interpretation to their result. It is noted that there are several ways to normalize the ninth axial-vector current by placing its divergence and the trace of the energy-momentum tensor in a representation of $U_1 \times U_1$. (auth)

5865 VANISHING OF THE SECOND-ORDER CORRECTION TO THE TRIANGLE ANOMALY IN LANDAU-GAUGE, ZERO-FERMION-MASS QUANTUM ELECTRODYNAMICS. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.); Brown, R. W.; Wong, T. F.; Young, B. -L. Phys. Rev., D; 4: No. 6, 1787-1808(15 Sep 1971).

Possible second-order radiative corrections to the axial-vector divergence anomaly in spinor electrodynamics are investigated. The procedure is to directly evaluate the shift terms which lead to the anomaly in zero-fermion-mass, Landau-gauge electrodynamics. This version of electrodynamics is chosen because it makes the electron propagator and vertex function finite, so that no infinite renormalizations need be dealt with in the anomaly calculation. It is found that the second-order corrections to the anomaly do vanish, in agreement with the work of Adler and Bardeen and with calculations (by different methods) of other authors. (auth)

5866 LORENTZ CONTRACTION OF THE BETHE–SALPETER GREEN'S FUNCTION. Kim, Y. S.; Zaoui, Roger (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 6, 1764-9(15 Sep 1971).

Lorentz-transformation properties of bound-state Bethe–Salpeter wave functions are discussed. It is noted first that the Lorentz-transformation effect comes through the Green's function in the Bethe–Salpeter integral equation. The transformation properties of the Green's function are then investigated in detail. It is shown that the Green's function exhibits a δ-function-like Lorentz contraction in the high-energy limit. It is shown also that the bound-state wave function has the same contraction property. (auth)

5867 RELATIVISTIC TRAJECTORIES FROM A CONFIGURATION-SPACE δ-SHELL INTERACTION. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 4: No. 6, 1707-16(15 Sep 1971).

The Regge spectrum generated by a four-dimensional δ-shell interaction $V(r) = \lambda\delta(r-a)$, where r is the four-dimensional radius, is investigated by means of exact solutions of the Wick-rotated Bethe–Salpeter equation. In this model only the leading trajectory can generate resonances. It is infinitely rising with $\mathrm{Im}\alpha/\mathrm{Re}\alpha < 1$. Odd daughter trajectories either develop negative imaginary parts or do not rise. Even daughter trajectories turn over above the elastic threshold. This spectrum is contrasted with that obtained from a δ-shell interaction in potential theory. The potential-theory model is characterized by an infinite set of parallel, infinitely rising trajectories. The equivalence between the partial-wave Bethe–Salpeter equation and the continuous-dimensional formalism used here is explicitly developed. Suggestions are made for extending the method to Bethe–Salpeter equations involving spin or multichannel effects. (auth)

5868 NONPOLYNOMIAL LAGRANGIAN FIELD THEORY WITHOUT ASYMPTOTOC EXPANSIONS. Chodos, Alan; Lane, Kenneth (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 4: No. 6, 1667-81(15 Sep 1971).

In an attempt to avoid the ambiguity found in most nonpolynomial Lagrangian theories in defining the S matrix, interactions are considered which generate N-point functions as Wick series in the Feynman propagator Δ which have a finite domain of convergence. In particular, for the case of a self-coupled, massive, neutral scalar field, a Lagrangian is chosen which generates particularly simple two-point functions. In the context of the usual Euclidean formulation of the theory, these two-point functions have either a single pole or a cut on the real $f^2\Delta$ axis, where f is the minor coupling constant. The analytic continuation of the Wick series is provided and it is shown that all two-point functions vanish on the light cone (i.e., as $f^2\Delta \to \infty$), so that Fourier transforms will be free of ultraviolet divergences. Motivated by the requirement that S matrix elements be real below threshold, a simple prescription is given for defining the Fourier integral over the singularities of the two-point function. This prescription is nonunique in that it defines the S matrix up to an arbitrary real constant times a known entire function of the energy. The second-order S matrix elements are shown to have precisely the analytic structure dictated by unitarity. (auth)

5869 POSITIVITY CONSTRAINTS ON DENSITY MATRICES. Deen, S. M. (Rutherford High Energy Lab., Chilton, Eng.); Kabir, P. K.; Karl, G. Phys. Rev., D; 4: No. 6, 1662-6(15 Sep 1971).

The requirements of positivity on Hermitian matrices are stated as conditions on the elementary symmetric functions c_j of the eigenvalues. The exact restrictions are found for matrices of arbitrary dimensionality; weaker conditions on the c_j are also given which hold in every case. (auth)

5870 MASSIVE QUANTUM ELECTRODYNAMICS IN THE INFINITE-MOMENTUM FRAME. Soper, Davison E. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 6, 1620-5(15 Sep 1971).

An earlier canonical formulation of quantum electrodynamics

in the infinite-momentum frame by replacing the photons with massive vector mesons is discussed. The structure of the theory remains nearly the same except that a new term appears in the infinite-momentum Hamiltonian describing the emission of helicity-zero vector mesons with an amplitude proportional to the meson mass. (auth)

5871 METHOD FOR STUDYING NONRENORMALIZABLE FIELD THEORIES. Nordstrom, D. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 6, 1611-19(15 Sep 1971).

A method is presented for studying nonrenormalizable quantum field theories in terms of renormalizable theories. The theory of a Hermitian scalar field in quintic self-interaction is modified by including in the Lagrangian a second-order derivative of the field variable. This additional term introduces a heavy particle with indefinite metric that acts as a cutoff on the momentum-space integrations. The most divergent part of this theory is shown to be analytically equivalent to the conventional ϕ^4 theory. It is then possible to use unitarity to relate the next most divergent part to the renormalizable most divergent part. (auth)

5872 ANOMALOUS SHORT-DISTANCE BEHAVIOR OF QUANTUM FIELD THEORY: A MASSIVE THIRRING MODEL. Mueller, A. H.; Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 6, 1635-52(15 Sep 1971).

The anomalous short-distance behavior of the products of quantum field operators, of the sort found in the Thirring model, is investigated. This is done by studying a modified Thirring model, based on a massive Fermi field $\psi(x)$, from several points of view in perturbation theory. This model has the same scaling short-distance behavior as the massless Thirring model. A modification is also constructed in which $\psi(x)$ is an isotopic-spin doublet in two dimensions. This model does not scale at short distance. The main conclusion is that the massive Thirring model scales at short distance because the special form of the interaction yields no charge renormalization. Further, this interaction allows a kind of gauge transformation under which S-matrix elements and current matrix elements are unchanged but which changes the scaling dimension. Thus, no physical significance can be attributed to this anomalous dimension. (auth)

5873 CHARGE SPECTRUM OF FOUR-COMPONENT FIELDS WITH O(4,2) SYMMETRY. Animalu, A. O. E. (Drexel Univ., Philadelphia). Phys. Rev., D; 4: No. 6, 1922-5(15 Sep 1971).

The charge spectrum of a four-component spinor field $\psi(x)$ given by the most general minimal linear parity-conserving current in the O(4,2) algebra of Dirac matrices for a composite spin-$\frac{1}{2}$ particle-antiparticle system with an arbitrary number N of mass eigenvalues m_τ ($\tau = 1, 2, \ldots, N$), where $N \geq 2$, is determined from the structure of the electromagnetic current density postulated recently by Barut, Cordero, and Ghirardi. To within a constant of proportionality, the charge spectrum is found to be fractional, of the form $(e_1, e_2, \ldots, e_N) = (e/N) \times (N-1), -1, \ldots, -1)$, which simulates the quark model of Gell-Mann and Zweig for N = 3. The implication on the mass spectrum of hadrons is discussed. (auth)

5874 EQUIVALENCE CLASSES OF MINIMUM-UNCERTAINTY PACKETS. II. Stoler, David (Polytechnic Inst. of Brooklyn). Phys. Rev., D; 4: No. 6, 1925-6(15 Sep 1971).

It was previously shown that all minimum-uncertainty packets are unitarily equivalent to the coherent states and that coherence may be viewed as stationary minimality. Some additional information relating to the nature of the unitary-equivalence structure is given. A new calculation of some matrix elements of the operator that implements the unitary equivalence is also given, which is not subject to the shortcoming inherent in the original calculation. (auth)

5875 QUANTIZATION OF SYSTEMS WITH SECOND ORDER DERIVATIVE COUPLING. Hood, Charles Gregory. Boston: Boston Univ. (1971). 117p. University Microfilms Order No. 71-26,425.

Thesis.

Several quantum field theory models of elementary particle interactions are based upon Lagrangian densities of the form $L = -\frac{1}{2}\partial^\mu\varphi F(\varphi)\partial_\mu\varphi + \alpha G(\varphi)$, where $F(\varphi)$ and $G(\varphi)$ are functions of φ, but not of $\partial_\mu\varphi$. If the usual approach to quantization is followed, the equations of motion derived from the Euler-Lagrange equation are different from the equations derived from the Heisenberg equations. This quantization difficulty also occurs in point quantum mechanics and has been discussed previously. It is shown that this approach fails to solve the problem. It is established that the inconsistency is due to ordering ambiguities which invalidate the normal chain rule of differentiation for this class of Lagrangians. A general quantization procedure is developed and applied to Lagrangians in point quantum mechanics and in quantum field theory. For point quantum mechanics one of the results of this study is that to secure consistent equations of motion, the usual representation of the Hamiltonian must be altered. A variational approach is also exhibited and is shown to be consistent with modifying the Hamiltonian. A number of different systems or quantizations are possible. These depend upon the Hamiltonian, the hermitization of L, and the explicit form of F(q). These differences are explored by considering solutions of the Schrödinger equation. Subsidiary conditions, such as the demand that the quantum Lagrangian be transformable to free-particle form when $\alpha = 0$, limit the number of quantizations allowed by the consistency of the equations of motion. A quantization is possible which exhibits all the characteristics of the corresponding classical, c-number Lagrangian, including the validity of the chain rule. For quantum field theory as in point quantum mechanics, the demand for consistent equations of motion allows many different quantizations. The relativistic analog of the classical free-field transformation uniquely determines one Lagrangian. It is shown that the quantization procedures developed herein do not affect relativistic covariance. As an application, the quantization of the Freund-Nambu model is considered. It is shown that when the above procedures are used, all properties of the c-number version of the model are preserved. (Diss. Abstr. Int., B)

5876 SCALE AND CONFORMAL INVARIANCE IN FIELD THEORY. Georgi III, Howard Mason New Haven: Yale Univ. (1971). 62p. University Microfilms Order No. 71-28,172.

Thesis.

Some constraints are found on a quantum field theory imposed by conformal invariance. The work is done in the context of Wilson's theory of symmetry breaking, extended to include conformal invariance rather than scale and Poincaré invariance only. The idea of a conformal invariant operator product expansion is introduced. This leads to the discovery of conformal towers, collections of fields which transform among themselves under conformal transformations. These, in turn, are related to scaling behavior. The Thirring model is investigated as an example of a conformal invariant field theory. The general properties expected of a conformal invariant operator product expansion are verified by example. It is then shown that the energy-momentum tensor in this theory can be written in the Sugawara form. Various commutation relations of the energy-momentum tensor are investigated. It is found that the local currents associated with the conformal generators can be expressed in terms of the energy-momentum tensor. (Diss. Abstr. Int., B)

Gravitation and General Relativity

Refer also to abstract 5127.

5877 SCHWARZSCHILD EXTERIOR SPACE-TIME. Agnese, A. G.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 2: No. 20, 1021-4(13 Nov 1971).

The problem of determining the static space-time representing the gravitational field outside a spherically symmetric distribution of matter with center at r = 0 is considered. The method used shows that the choice of a particular metric implies the choice of a corresponding particular behavior of the gravitational potential. The position of the Schwarzschild singularity follows from this choice. (L.B.S.)

5878 REMARK ON TRAPPED SURFACES IN GENERAL RELATIVITY. Dautcourt, G. (Central Inst. for Astrophysics, Potsdam, Ger.). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 7, 663-6(1971).

The necessary conditions for the existence of trapped surfaces are studied; it is shown that they can occur only in strongly curved space-times. (auth)

5879 CHARACTERISTIC INITIAL DATA FOR GRAVITATIONAL VACUUM FIELDS. Dautcourt, G. (Central Inst. for Astrophysics, Potsdam, Ger.). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 7, 667-70(1971).

This paper gives the characteristic initial data for gravitational vacuum fields which are invariants of the two initial null hypersurfaces and their space-like section Σ. (auth)

5880 CHARGED DUST SPHERES IN GENERAL RELATIVITY. Bohra, M. L.; Mehra, A. L. (Jodhpur Polytechnic, India). Gen. Relativity Gravitation; 2: No. 3, 205-9(1971).

The balanced field equations of general relativity were used for presenting a model for a sphere of charged dust having dif-

ferent densities of matter and charge. The Schwarzschild's and Penney's solutions are the particular case of the solution obtained. Further equations are solved to get a model in which gravitational attraction and electrical repulsion balance each other. (auth)

5881 QUANTUM FALLING CHARGES. Dewitt, Cecile M. (Univ. of North Carolina, Chapel Hill); Wesley, Walter G. Gen. Relativity Gravitation; 2: No. 3, 235-45(1971).

The quantum mechanical analog of the problem of a charged particle falling in a gravitational field is studied in order to compare quantum and classical results. The interaction considered is that between a charged scalar meson and an external gravitational field resulting in the emission of a photon. It is found that the differential cross section and energy loss agree with the classical results for a low energy meson. A brief discussion of radiative corrections to the meson-gravitational field interaction is given in order to point out a difficulty which apparently arises when the cut-off method of handling divergent integrals is used. (auth)

5882 NON-COVARIANT THEORY OF GRAVITATION. II. Rosen, Nathan (Israel Inst. of Tech., Haifa). Gen. Relativity Gravitation; 2: No. 3, 223-34(1971).

This is a continuation of previous work in which a theory of gravitation was developed based on the existence of a preferred frame of reference and a preferred time coordinate in the universe. The gravitational field equations are derived with the help of a variational principle containing three constants. Two relations among the constants are introduced, leaving one of them arbitrary. This constant does not affect the precession of the perihelion of Mercury but does affect the behavior of gravitational waves. By changing one of the relations among the constants, one can account for the discrepancy in the precession of the perihelion associated with the oblateness of the sun, as found previously. (auth)

5883 GRAVITATIONAL FERMION INTERACTIONS. Lawrence, John K. (Univ., Vienna). Gen. Relativity Gravitation; 2: No. 3, 215-22(1971).

The scattering of unpolarized fermions and scalar mesons by single graviton exchange is considered by means of a Feynman graph type perturbation theory scheme. In the limit of scattering of the fermions by very heavy mesons, the cross section for fermions scattering in a Schwarzschild metric is obtained. The result obtained conflicts with an earlier result, (1958). In the limit of scattering of massless fermions (neutrinos) with massless scalar mesons it is seen, using Weinberg's treatment of soft graviton bremsstrahlung, that the cosmological red shift of light cannot be explained by interactions of the light with intergalactic neutrinos. (auth)

5884 ARE SPATIAL AND TEMPORAL CONGRUENCE CONVENTIONAL. Grunbaum, Adolf (Univ. of Pittsburgh). Gen. Relativity Gravitation; 2: No. 3, 281-4(1971).

A rebuttal of previous work in which it was argued that a previous thesis of the metrical amorphousness of space and time does not illuminate and does not draw support from the general theory of relativity is given. (UK)

5885 CANONICAL QUANTIZATION WITH QUADRATIC CONSTRAINTS. Kaup, David J. (Clarkson Coll. of Tech., Potsdam, N. Y.). Gen. Relativity Gravitation; 2: No. 3, 247-79(1971).

Based on an analysis first suggested previously, it was found that a special case of the general classical theory involving quadratic constraints can be quantized canonically, in the sense that the quantum constraints are consistent. In particular, this special case contains all known physical theories of bosons, including Einstein's general theory of relativity. The quantum constraints for this theory are given explicitly. (auth)

5886 RIEMANNIAN FOURFOLDS OF CLASS ONE. Tiwari, R. N. (Indian Inst. of Tech., Kharagpur). Gen. Relativity Gravitation; 2: No. 3, 211-14(1971).

In view of the well known theorem that there exist no spaces of class one for which all the components of Ricci tensor are zero, the only allowable gravitational effects in a V_4 of class one are those due to material distribution or radiation. This prompted examination of the properties of a V_4 embedded in five-flat through the solutions obtained from the point of view of physical distributions. In this work which is a continuation of previous work the perfect fluid distribution for spherically symmetric distribution of class one is considered. The particular solution obtained leads to the idea of "negative mass." (UK)

5887 VERIFICATION OF EQUIVALENCY OF INERTIAL AND GRAVITATIONAL MASSES. Braginskii, V. B.; Panov, V. I. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 3, 873-9(Sep 1971). (In Russian).

An experiment is described which establishes with an accuracy to $0.9(10)^{-12}$ (confidence level 0.95) that the ratios of the inertial to gravitational masses for aluminum and platinum are the same. A torsion pendulum with a proper oscillation period of 5 hours and 20 minutes and relaxation time exceeding $6(10)^7$ sec was used in the experiments. An analysis of imitating effects which restricted the resolution is performed. The quantity $0.9(10)^{-12}$ is close to the ratio of the strong and weak interaction energy constants. (auth)

Scattering Theory

Refer also to abstract 6111.

5888 SLOPE DIFFRACTION SCATTERING AND A REMARKABLE KINEMATIC VARIABLE. Leader, E.; Pennington, M. R. (Westfield Coll., London). Phys. Rev. Lett.; 27: No. 19, 1325-8 (8 Nov 1971).

Group-theoretical analysis suggests the introduction of a new kinematical variable. Data on diffraction scattering exhibit remarkable universality in this variable. An s-dependent slope formula is obtained which fits both K^+p and pp elastic scattering at all measured energies. (auth)

5889 MAGNITUDE OF ABSORPTIVE CORRECTIONS TO SCATTERING PROCESSES. Lichtenberg, D. B. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B33: No. 2, 485-92(1971).

It is shown that, in a class of soluble models, the second-order unitarity corrections to the Born approximation are equal to the second-order "absorptive model" corrections multiplied by a factor λ given by $\lambda = \frac{1}{2}\sigma(\text{total})/\sigma(\text{elastic})$. (auth)

5890 CONSTRUCTION OF CROSSING-SYMMETRIC UNITARY SCATTERING AMPLITUDES. Warnock, Robert L. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.). Fields Quanta; 2: No. 1, 1-50(Sep 1971).

The question of how to construct scattering amplitudes which satisfy the postulates of S matrix theory is reviewed. The review traces the development of the theory from the early formulation of the Chew-Low equation to the recent proofs of existence of amplitudes with Mandelstam analyticity, crossing, and unitarity. The problem of constructing amplitudes is viewed as having two parts. The first part is to solve the partial-wave dispersion relation with given left-hand cut and given elasticity. The solution of this part by the N/D method, and the associated matter of CDD poles, is briefly summarized. The more difficult second part, which has to do with imposing crossing symmetry and Mandelstam analyticity, is considered as a problem in nonlinear functional analysis. Elementary tools of the latter subject (fixed point theorems, implicit function theorems) are introduced and applied to the Low equation and to the Mandelstam crossing-unitarity equation. Some comments are made on the outlook for S matrix dynamics. (auth)

5891 CONSTRUCTION OF UNITARY, COVARIANT S MATRICES DEFINED BY CONVERGENT PERTURBATION SERIES. Fivel, Daniel I. (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 6, 1653-62(15 Sep 1971).

A method is given for the construction of S matrices which are unitary and covariant. Moreover, the S matrix elements are the analytic continuations to timelike momenta of quantities which are defined by convergent perturbation series for Euclidean momenta. It is shown that the S matrix in the Euclidean region has the same form as the correlation functions of classical gases which interact through stable, regular pair potentials. The known results on the existence of a thermodynamic limit and convergence of activity (fugacity) series for such gases are exploited in the S-matrix theory. Approximation schemes suggested by the analogy are noted. (auth)

5892 EIKONAL APPROXIMATION FOR THREE-PARTICLE SCATTERING. Kelly, R. L. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 4: No. 6, 1755-63(15 Sep 1971).

The behavior of the $3 \rightarrow 3$ amplitude in nonrelativistic potential scattering is investigated at high energies and small momentum transfers. An approximation scheme is proposed which involves only on-shell two-body amplitudes. The single- and double-scattering terms are obtained from the Watson–Faddeev equations. An eikonal approximation for the triple-scattering term is developed, and the result is expressed as a one-dimensional integral over the product of the three two-body amplitudes. (auth)

5893 FACTORIZATION OF MULTI-REGGE AMPLITUDES. Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 6, 1777-86(15 Sep 1971).

In order to gain insight into the problem of factorization of multi-Regge amplitudes, the dual-resonance model is studied in detail. The full amplitude, as well as its total-energy discontinuity, are shown to factorize in the multi-Regge limit, although this is by no means a trivial consequence of the well-known factorization of a single generalized beta-function term. Factorization is found to depend crucially upon taking into proper account the singularities in energy variables which are dependent due to nonlinear Gram-determinant constraints. This result suggests how the apparent nonfactorization of the full multi-Regge amplitude recently pointed out by Dash may be generally circumvented. An application of the factorization of the total-energy discontinuity to the phenomenology of inclusive cross sections is discussed. (auth)

5894 EXCHANGE OF COHERENT PARTICLE STATES AND THE RELATIVISTIC EIKONAL EXPANSION. Gundzik, M. G. (Univ. of Texas, Austin); Nussinov, S. Phys. Rev., D; 4: No. 6, 1866-72(15 Sep 1971).

A nonpolynomial Lagrangian model for the description of high-energy scattering processes is investigated. The interaction between primary scalar particles corresponding to the operator $\psi(x)$ is mediated by an appropriate coherent state $\eta(x)$ of secondary scalar particles of mass μ described by the single-particle operator $\kappa(x)$ with annihilation and creation operators $a(\vec{k})$, $a^{\dagger}(\vec{k})$ satisfying the usual commutation relations. In this picture an effective Lagrangian is introduced with the form $L_I(x) = G: \psi^{\dagger}(x)\eta(x)\psi(x)$. The corresponding term of order G in the S-matrix expansion contributes to the high-energy multiparticle vertex. Calculating the propagator for the field $\eta(x)$, one finds that the contribution to the scattering amplitude due to the single-coherent-state exchange has the form of a generalized relativistic eikonal approximation. This is related to the usual eikonal form (EF) of a particular subset of Feynman diagrams. The corrections to the high-energy EF are viewed as the deviations from pure coherent-state exchange contained in the perturbation expansion for L_I. The generalization of this approach to spin is indicated. (auth)

5895 FORWARD-DIRECTION AMATI–BERTOCCHI–FUBINI–STANGHELLINI–TONIN EQUATION: VALADITY OF THE TRACE APPROXIMATION AND SPECTRUM OF THE OUTPUT POLES. Misheloff, Michael N. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 6, 1888-96(15 Sep 1971).

The validity of the trace approximation to the forward-direction ABFST equation is discussed. It is shown that the trace approximation must fail as ReJ decreases while ImJ is kept fixed. Nevertheless, it is demonstrated that the trace approximation can be used to locate the poles in a region which is roughly described by the wedge $\mathrm{ReJ} \lesssim -\pi|\mathrm{ImJ}|/\ln|m_\pi^2/4m_\pi^2)$. Using these results, it is proved that there are an infinite number of output poles in all isospin channels. The spectrum of the poles is discussed qualitatively. (auth)

5896 UNITARY MODELS OF THE POMERANCHUK SINGULARITY. Fulco, J. R.; Sugar, R. L. (Univ. of California, Santa Barbara). Phys. Rev., D; 4: No. 6, 1919-21(15 Sep 1971).

Two models of production amplitudes are presented which do not lead to a violation of the Froissart bound when the leading Regge singularity reaches J = 1. Both models have a bootstrap solution with the two-body amplitude having the form $[(J-1)^2 - R_0^2 t]^{-\frac{1}{2}}$. (auth)

5897 HYPERSPHERICAL FUNCTIONS IN THE FIVE-BODY PROBLEM. Kil'dyushov, M. S.; Surkov, E. L. (Moscow Physical-Technical Inst.). Yadern. Fiz.; 14: No. 3, 551-66(Sep 1971). (In Russian).

A method to construct hyperspherical functions of a definite exchange symmetry is presented for the quantum five-body problem. With this in view the embedding problem is solved, $O_4 \supset S_5$. The matrix transforming the canonical basis $O_4 \supset O_3 \supset O_2$ into the basis corresponding to the reduction $O_4 \supset S_5 \supset S_4 \supset S_3 \supset S_2$ is obtained by means of the method of factorization of the projection operators. The case of the reduction $O_4 \supset S_3 \supset S_3 \otimes S_2$ is considered. Results of the calculations that enable one to construct the hyperspherical polynomials with a definite symmetry for $k < 5$ are given in tables. (auth)

Particle Accelerators

Refer also to abstracts 4190, 4610, 4611, 5432, and 5962.

5898 (CEAL–1056) SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY 1–JUNE 30, 1971. Strauch, K.; Shurcliff, W. A. (Cambridge Electron Accelerator, Mass.). 21 Jul 1971. Contract AT(30-1)-2076. 49p. Dep. NTIS.

Essentially all effort is now being concentrated on the colliding beam project (Bypass) and the two detection systems (BOLD and MAGNOLIA) being built to analyze the results of the colliding beam events. The development and operation of the accelerator are summarized, and the publications are listed. (W.H.K.)

5899 (INR–1306) NUCLEAR STRUCTURE STUDIES WITH ON-LINE ISOTOPE SEPARATION METHODS. I. TECHNICAL PROBLEMS AND APPLICATIONS OF THE ON-LINE ISOTOPE SEPARATION. Jastrzebski, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1971. 55p. (In Polish). Dep. NTIS (U. S. Sales Only).

A description of the on-line isotope separation method for the study of nuclei far-off the beta stability line is presented. The ISOL systems/Isotope Separator On Line/ developed in different laboratories are reviewed. Some applications to the nuclear structure and nuclear reaction studies are discussed. (auth)

5900 (LA-tr-71-76) LIOUVILLE THEOREM AND THE GENERAL PROBLEM OF STABILITY. Fronteau, J. (European Organization for Nuclear Research, Geneva (Switzerland)). Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from report CERN-65-38. 43p. Dep. NTIS.

The original form of Liouville's theorem is recalled which seems to have been widely forgotten, and a few historical references are given in this connection. Then the link is shown existing between Liouville's theorem and the general problem of stability according to Lyapunov. Temporarily disregarding Hamiltonian phase space (x_i, p_{xi}) in favor of (x_i, x_i')-space, it is subsequently shown that Liouville's theorem forms a link between the behavior of the system in (x_i, x_i')-space and the relativistic energy exchanges with the external world. Finally, it is remarked that the results given—apart from being of interest to physicists wishing to know more about a theorem which is so often mentioned—may also be useful to accelerator theoreticians, plasma experts and, possibly, radio-astronomers. (auth)

5901 (LUSY–7001) BEAM MONITORING SYSTEM USED AT THE LUND ELECTRON SYNCHROTRON. Jarlskog, G.; Korder, D.; Larsson, C. (Lund Univ. (Sweden). Dept. of Physics). May 1970. 20p. Dep. NTIS (U. S. Sales Only).

A beam monitoring system using ionization chambers with integrators is described. Results obtained in calibrating a Wilson-type quantameter against an identical precalibrated quantameter are given. (auth) (Sweden)

5902 (NP–18850) IPCR CYCLOTRON PROGRESS REPORT, 1970. VOL. 4. (Institute of Physical and Chemical Research, Tokyo (Japan)). Dec 1970. 160p.

ALUMINUM-27—carbon-12 reactions (C-12, N-13) at 80 MeV, differential cross sections and spectra from, (E)
BARIUM-133—preparation of metastable, from cesium-133 (d,2n) reactions
BETA SOURCES—preparation of niobium-90 positron, from zirconium-90 (d,2n) reactions
CADMIUM-109—electron-capture decay of, charge states of silver produced in, (E)
CALCIUM-42—energy levels of, g factors for, (E)
CARBON-11—escape from melt of pure silicon, method for measuring
CARBON-12—helium-3 reactions (He-3,α) at 24.0 to 39.6 MeV, differential cross sections and spectra from, (E)
—helium-3 elastic and inelastic scattering at 24.0 to 39.6 MeV, optical-model analysis of differential cross sections for, (E)
CYCLOTRONS—development and operation of IPCR, Nov., 1969 to Nov., 1970
—experimental facilities at IPCR, description of
FLUORINE-18—escape from melt of pure silicon, method for measuring
FURAN, TETRAHYDRO-—radiolysis of, yields from γ, helium, and nitrogen
GADOLINIUM-147—beta and electron-capture decay of, conversion-electron spectra and K-conversion coefficients from, (E)
GATING SYSTEMS—design and performance of gate and delay generator
HELIUM—carbon ion reactions at 3.2 to 7.5 MeV/nucl., cross sections for charge exchange in, (E)
HYDROGEN—carbon ion reactions at 3.2 to 7.5 MeV/nucl., cross sections for charge exchange in, (E)
INDIUM-111—preparation of, from silver-109 (α,2n) reactions
IRON IONS—yields of ferric, from heavy-ion radiolysis of ammonium iron sulfates
IRON-54—proton elastic and inelastic scattering at 10 to 14 MeV, optical-model analysis of angular distributions and spin-flip probabilities from, (E)

IRON-56—proton elastic and inelastic scattering at 10 to 14 MeV, optical-model analysis of angular distributions and spin-flip probabilities from, (E)
LEAD-203—preparation of, from thallium-203 (d,2n) reactions
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MAGNESIUM-24—deuteron reactions (d,Li-6) at 24 MeV, DWBA analysis of angular distributions and spectra from, (E)
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POLONIUM-201—energy levels from (HI,xn) reactions, spin-parity assignments for, (E)
POLONIUM-202—energy levels from (HI,xn) reactions, spin-parity assignments for, (E)
POLONIUM-203—energy levels from (HI,xn) reactions, spin-parity assignments for, (E)
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POLONIUM-210—energy levels of, g factors for, (E)
RADIATION MONITORING—program at IPCR cyclotron, Nov. 1969 to Nov. 1970
RADON-206—energy levels from (HI,xn) reactions, spin-parity assignments for, (E)
RARE GASES—carbon ion reactions at 3.2 to 7.5 MeV/nucl., cross sections for charge exchange in, (E)
SCHIZOMYCOTA—Escherichia coli, radiosensitivity of log-phase cells of B/r and B_s-1, LET effects on
—Micrococcus radiodurans, radiosensitivity of log-phase cells of R_1, LET effects on
—Bacillus subtilis, radiosensitivity of spores of, LET effects on
SILVER—atomic charge states of, produced by cadmium-109 electron-capture decay, (E)
STRONTIUM-82—energy levels from germanium-74 (C-12,4n) reactions, spin-parity assignments for, (E)
STRONTIUM-84—energy levels from germanium-76 (C-12,4n) reactions, spin-parity assignments for, (E)
TIN-119—chemical state of, following antimony-119 electron-capture decay, effects of physicochemical properties of host antimony compound on
TITANIUM-46—deuteron reactions (d,Li-6) at 24 MeV, angular distributions from, (E)
VINYL ALCOHOL POLYMERS—radiolysis of aqueous, effects on viscosity of α
YTTRIUM-81—beta decay of, half-life and gamma spectra from, (E)
ZIRCONIUM-90—energy levels of, g factors for, (E)
—deuteron reactions (d,2n) at 12 to 22 MeV, excitation function for, (E)

5903 (NP-19077) CALCULATIONS OF PHASE FOCUSING OF INTENSE CLUSTERS OF CHARGED PARTICLES IN DIRECT ACTION ACCELERATORS. Kuznetsov, V. S.; Avramenko, M. I.; Kuznetsova, N. P.; Fidel'skaya, R. P.; Nikol'skii, M. A. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

A calculation method is described for variation of axial extension and radial dimensions of intense bunches of charged particles in direct current accelerators. This calculation method takes into account nonlinearity of distribution of Coulomb forces in a bunch and velocity spread of particles. It is shown that the above factors determine an ultimate achievable coefficient of bunching at the accelerator exit. Results of concrete calculations are given and compared to experimental data. (auth)

5904 (NP-19078) SPECIAL FEATURES OF THE HIGH FREQUENCY SYSTEM OF A SYNCHROCYCLOTRON AT 1-GeV PROTON ENERGY. Roife, I. M.; Seredenko, E. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Basic calculation results of the synchrocyclotron r.f. system are presented. Operation peculiarities of the dee circuit as a distributed oscillating system are estimated. A formula is given of equivalent induction, taking account of the rotating capacitor connection at a narrow section of the dee. The effect of the rotating capacitor asymmetry is investigated. The basic peculiarities of the variator scheme are described. Possibilities of exciting and suppressing the parasite types of oscillations are discussed. (auth)

5905 (NP-19079) PARAMETERS OF THE ELECTROCONDUCTIVE COATING OF THE ACCELERATOR TUBES OF A LINEAR INDUCTION ACCELERATOR. Vakhrushin, Yu. P.; Gagen-Torn, V. K. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Requirements for electroconducting coating of the acceleration tube are substantiated. Expressions are derived, which allow to determine the value of the coating conductivity and tolerable value of its inhomogeneity. The operation conditions are considered. The known types of coatings are analyzed and it is concluded that coatings based on stannum-oxide can meet the requirements. (auth)

5906 (RHEL/R-225) OPERATION AND PERFORMANCE OF THE FROZEN TARGET AND POSSIBLE IMPROVEMENTS. Russell, F. M. (Rutherford High Energy Lab., Chilton (England)). Aug 1971. 25p. Dep. NTIS (U. S. Sales Only). UK 30p.

The predicted performance of the RHEL polarized proton target, in which the functions of polarizing and HEP data collection are separated by using the principle of freezing-in the polarization, now can be given on the basis of a minimum magnetic field strength in the target of 25 kG in the holding position. The target material is 50% Glycerol and 50% water with about 0.8% porphyrexide. Limitations of the existing system are examined and possible developments are outlined. (UK)

5907 CYLINDRICAL MIRROR ANALYZER WITH SURFACE ENTRANCE AND EXIT SLOTS. I. NONRELATIVISTIC PART. Sar-El, H. Z. (Soreq Nuclear Research Centre, Yavne, Israel). Rev. Sci. Instrum.; 42: No. 11, 1601-6(Nov 1971).

The properties of the cylindrical mirror analyzer are discussed for the case where its entrance and exit slots are on the surface of the inner electrode. A comparison with the case where the slots are on the axis shows that although the axial arrangement is superior, the surface case is more compact. It seems also that sample alignment in the surface case is not as critical as in the axial arrangement. (auth)

5908 PLANE MOTION IN A CENTRAL LOGARITHMIC POTENTIAL: ANALYTICAL PROPERTIES OF THE ORBIT. de Celles, Michel (Univ. Laval, Quebec). Can. J. Phys.: 48: 2192-2200(15 Sep 1970). (In French).

Plane motion in a central logarithmic potential is studied for the purpose of using the cylindrical condenser as an electrostatic mirror. It is shown that the quadrature for the orbit can be transformed to a contour integral. The contour is such that the orbit dependence on energy and angular momentum does not involve the limits of integration. This makes it unnecessary to calculate the apsidal distances separately before integrating. Expansions for the orbit formula can then be obtained in a simple manner, as only the integrand depends on energy and angular momentum. One example of expansion is given and its properties are studied. (auth) (Canada)

5909 FIRST-ORDER THEORY OF ELECTRICAL FOCUSING IN CYCLOTRON-TYPE TWO-DIMENSIONAL LENSES WITH STATIC AND TIME-VARYING POTENTIALS. Reiser, Martin (Univ. of Maryland, College Park). J. Appl. Phys.; 42: No. 11, 4128-38(Oct 1971).

The potential distribution in cyclotron-type gaps with liner (outer electrodes at ground potential) is determined via Schwarz-Christoffel transformation, as well as by computer analysis (relaxation method). First-order focusing formulas for both static, as well as time-varying, potentials are derived. In addition exact calculations were carried out by direct numerical integration of the equations of motion with a computer program. The numerical data permitted an accurate evaluation of the validity of the analytical approximation, as well as further improvement of the theoretical formulas. Focusing relations are presented in a generalized form which shows the scaling laws and is readily applicable to different types of particles, energies, or lens geometries. As an example, the theory is applied to the axial motion of ions in a cyclotron. (auth)

5910 HIGH SENSITIVITY METHOD FOR MEASURING MAGNETIC FIELD INTEGRALS. Cattoni, A.; Piccolo, M.; Ronga, F. (CNEN, Frascati, Italy). Nucl. Instrum. Methods; 96: No. 4, 573-80(1971).

A prototype for measuring the field integral along the straight section occupied by the magnetic detector to be used at the storage ring Adone has been constructed. This instrument, made by an electromagnetic balance, has a sensitivity better than 2 Gm. (auth)

5911 FLUORESCENT SCREEN AS A HEAVY ION BEAM INDICATOR. der Mateosian, E.; Kistner, O. C.; Thieberger, P. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 96: No. 4, 613(1971).

A fluorescent screen for use in heavy ion beams is described. (auth)

5912 CHARGED PARTICLE BEAM DENSITY MEASUREMENT DEVICE. Vogel, Uriel (to United States Atomic Energy Commission). U. S. Patent 3,600,580. 17 Aug 1971. Filed 22 Sep 1969.

Apparatus for measuring the location and intensity profile of a charged particle beam by moving a wire with high velocity, in a plane, transversely through the beam is described. The wire spills a small portion of the beam for accurately generating signals from the spilled portion of the beam corresponding to the location and the density profile of the beam. (auth)

5913 ELECTRON BEAM MONITOR. Fujino, Takahiro; Yoshida, Toshio; Oka, Takashi. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 108-10(1970).

A monitor for the electron beam from an accelerator is described. The electron beam is monitored by measuring a small part of the beam which is periodically deflected for a short duration by a pulsed magnetic field. (auth)

5914 IMPROVED ACCELERATION DEVICES FOR THE SYNCHROTRON. Vizir, V. A.; Lashuk, N. A.; Solntsev, B. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 139-41(1971). (In Russian).

The most important task in the construction of the rf system of the synchrotron "Sirius" was the resonator design and the production of the desired high frequency voltage (300 kV). The design of a resonator which would enhance the stability of its natural frequency and suppress the mechanical auto-oscillation is discussed. The use of one or two parallel discs or coaxial cylinders for this purpose is illustrated, and test results in the form of oscillograms are considered. For example, with 4-mm thick discs, 750 mm in diameter, and a gap of 26 mm, the percentage modulation obtained at 50 kV was 50%. (K.S.W.)

5915 VARIABLE GEOMETRY SEPARATOR AND LOW ENERGY HEAVY ION ACCELERATOR. Freeman, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 420-30 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The new Harwell isotope separator and heavy ion accelerator which are described were designed as a low cost, compact laboratory facility for the separation of high purity isotopes as well as for a wide range of ion interaction studies. The novel focusing arrangements permit considerable experimental flexibility with a resolution and dispersion comparable with much larger conventional separators. The high beam intensity (≥mA) of the machine is adequate for production scale semiconductor doping. (auth)

5916 ON-LINE MASS SPECTROMETRY. Bernas, R. (CNRS, Orsay, France). pp 535-47 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The development of a mass spectrometer on-line with an accelerator for studying short-lived isotopes is described. (W.H.K.)

5917 MICROTRON FOR THE RADIATION PHYSICS OF SEMICONDUCTORS. Seryapin, V. G.; Patrenin, V. A.; Limasov, Yu. M. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 350-2(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 21-3(Mar-Apr 1971).

A microtron was created for research in the radiation physics of semiconductors. The distinguishing feature of the microtron construction lies in the presence of two magnetic extraction channels. The reliability of the individual sections has been increased considerably. The service life of the electron source has been brought up to 1000 h of continuous operation when the helixes are replaced every 80 to 100 h. (auth)

5918 EFFECTS OF OXIDE FILMS ON SURFACE RESISTANCE AND PEAK FIELDS OF SUPERCONDUCTING NIOBIUM CAVITIES. Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 4, 335-41(Oct 1971).

The results of an investigation of residual surface resistance R_{res} and peak rf magnetic fields $\hat{B}$ of large grain niobium cavities in the frequency range of 2 to 4 GHz are presented. It is shown that anodizing the cavities changes the frequency dependence of R_{res} for TM_{01n} modes. Furthermore, comparison is made of Q and breakdown magnetic field $\hat{B}_B$ before and after anodizing. The highest $\hat{B}_B \approx 550$ G were measured in the TM_{010} and TE_{111} modes for cavities heat treated at 1850°C with no oxide film. The Q's of anodized cavities deteriorate when kept at room temperature even under good vacuum (10^{-7} torr range). Possible mechanisms for this deterioration are suggested. (auth) (UK)

5919 ACCELERATION OF AN ELECTRON BEAM IN A CIRCULAR CYLINDRICAL SUPERCONDUCTING CAVITY OPERATING IN THE TM_{010} MODE. Boussoukaya, M.; Septier, A. (Univ. Paris, Orsay, France). Particle Accel.; 2: No. 4, 305-11 (Oct 1971). (In French).

The possibility of accelerating electrons injected at low energy (≈35 keV) into a short cylindrical superconducting cavity working in the TM_{010} mode was explored. For an axial electric field value of 40 MV/m, output energies of 2 MeV could be obtained in L-band. The energy spectrum width could be reduced to less than 10^{-2} in relative value, the injected electron beam being chopped into very short bunches (phase angle range less than 20°) around an optimum injection phase angle ϕ_0. Taking into account the fringing fields, a study of the radial motion of these electrons shows an important focusing effect during acceleration. No variations of the emittance are observed for a paraxial beam. (auth) (UK)

5920 CONCEPT AND DESIGN OF THE BROOKHAVEN PROTON SPECTROMETER. Sutter, R. J. (Brookhaven National Lab., Upton, N. Y.). pp239-64 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The general principles and problems encountered in building a piece of apparatus such as the Brookhaven Proton Spectrometer are discussed by reviewing the history of this instrument. The method used was that of magnetic analysis, with particle position determined by wire spark planes. The design and operation of the spark plane system is described. The use of the system to measure scattering cross sections is explained. A few examples of the variety of data taken by the spectrometer are given. The paper concludes by discussing the electronics and on-line computer facility employed; these consisted of the fast electronics for servicing the scintillation counters, the spark plane readout system, the data assembler, and the computer. (R.W.R.)

5921 LOS ALAMOS MESON PHYSICS FACILITY (LAMPF). Nagle, D. E. (Los Alamos Scientific Lab., N. Mex.). pp 284-93 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The design parameters of the LAMPF are reviewed, and the associated experimental facilities are described. (R.W.R.)

5922 TRIUMF: DESIGN OF INITIAL FACILITY AND POSSIBLE DEVELOPMENTS. Warren, J. B. (Univ. of British Columbia, Vancouver). pp 294-314 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The design of the TRIUMF is described. Features of the machine presented include the magnet, rf system, vacuum system, ion source and injection system, and residual radiation studies. Experimental facilities discussed are the proton area and meson area, targets and beam lines. Future developments as to cyclotron performance and extension of the experimental facilities are mentioned. (R.W.R.)

5923 INDIANA UNIVERSITY 200-MeV CYCLOTRON FACILITY. Singh, P. P. (Indiana Univ., Bloomington). pp 315-26 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

A status report on the Indiana University 200-MeV cyclotron facility is presented. Specifications for the machine itself, the building layout, experimental facilities, and proposed research programs are included. (R.W.R.)

5924 EQUIPMENT FOR MEASURING SMALL MAGNETIC FIELDS IN THE RING ELECTROMAGNET OF A PROTON SYNCHROTRON. Vasil'ev, M. P.; Gorelkin, A. S.; Dubasov, V. G.; Mozin, I. V. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 355-60(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 26-30(Mar-Apr 1971).

Equipment for investigating the magnetic field of the ring electromagnet in a proton synchrotron with hard focusing is described. The equipment is designed for comparing values of the field intensity and its gradient during one cycle of field variation, averaged over the length of an electromagnet stack. Magnetomodulation pickups are used as the magnetic sensing elements. The measurements were carried out at a field intensity of $5.5 \cdot 10^3$ A/m on the equilibrium orbit. The sensitivity of the equipment, which was determined by the value of the lowest digit of a digital voltmeter, was 0.001% with respect to the field and 0.003% with

respect to the field gradient. The error of the equipment in measuring the field did not exceed 0.015%, while the error was 0.03% for measuring the field gradient. (auth)

5925 HIGH POWER LOSS MECHANISM IN SUPERCONDUCTING MICROWAVE CAVITIES. Ferrari, L. A. (Queens Coll., New York). Particle Accel.; 2: No. 4, 283-7(Oct 1971).

The energy transmitted to a tenuous electron gas and subsequently delivered to the walls of a superconducting microwave TM_{010} mode cavity is computed. It is found that the cavity Q via this mechanism is proportional to various positive powers of the frequency, depending on the approximations used to solve the equations of motion. With an electron density of 10^1 to 10^2 cm^{-3} the Q at high power levels ($E \approx 10^7$ V/m) is approximately 10^8–10^9 at L-band frequencies. Cavities with radial nodes in the electric field strength are suggested as a means to reduce these losses. (auth) (UK)

5926 CERN PROTON SYNCHROTRON ORBIT DISPLAY. Boucheron, J.; Boussard, D.; Ollenhauer, F.; Schneider, G. (CERN, Geneva). Particle Accel.; 2: No. 4, 315-24(Oct 1971).

The automatic orbit display of the CERN proton synchrotron, which is now in operational use, is described. It makes use of 40 electrostatic pick-up stations which provide the fast analog signals. These signals are processed, digitized and fed into the IBM 1800 computer which calculates the corresponding beam positions. The system is able to follow the trajectory of one particular bunch during more than one machine turn. A description of the electronic circuitry, including synchronization, acquisition and calibration subsystems, is given. By using various comparative methods, the results of which are presented, the accuracy of the whole system was determined. (auth) (UK)

5927 MEASURING THE COORDINATES OF THE CENTER OF GRAVITY OF A BEAM OF CHARGED PARTICLES BY MEANS OF A PROPORTIONAL CHAMBER. Biryukov, V. A.; Zinov, V. G.; Konin, A. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 367-9(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 36-8(Mar-Apr 1971).

A method is proposed for the direct measurement of the coordinates of the center of gravity of a beam of charged particles (without preliminary determination of the beam profile) and for continuous observation of the time variation of the coordinates. For these purposes a proportional chamber is used. The integrated currents flowing through the loads at the terminals of the working circuit of the counter are compared. The results of an experimental check carried out on a particle beam created by an α source are presented. (auth)

5928 AUTOMATIC FREQUENCY CONTROL IN MICROTRON. Zhulinskii, S. F.; Luk'yanenko, E. A.; Mirzoyan, A. R. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 353-4(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 24-5(Mar-Apr 1971).

A system for automatic frequency control of the accelerating cavity in a 25-MeV microtron is described. The system eliminates the mutual detuning of the oscillator and cavity when the microtron operates, and thereby simplifies accelerator control. (auth)

5929 USE OF PRESSED POROUS NICKEL-OXIDE CATHODES TO OBTAIN INTENSE ELECTRON BEAMS. Rybas, K. P.; Pavlov, V. K.; Telepaev, B. N. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 364-6(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 33-5(Mar-Apr 1971).

The possibility of obtaining a high emission current density from pressed porous nickel-oxide cathodes (BN-cathodes) having a diameter of 50 mm with a spherical emitting surface at a voltage of 100 kV and a pulse length of 0.2 μsec was investigated. It is shown that the indicated cathode has an emission current density of 110 A/cm^2 and a brightness temperature 970°C in an operating mode in which the current is space-charge limited; under these conditions the emission does not depend on the pressure of the remanent gases in the $2 \cdot 10^{-6}$ to $4 \cdot 10^{-4}$ torr range. The cathode may be repeatedly exposed to air without a noticeable reduction in emission. (auth)

5930 INJECTION OF RELATIVISTIC PARTICLES INTO A RAPIDLY INCREASING MAGNETIC FIELD. Borisov, D. G.; Grislov, A. I. (Scientific Research Inst. of Electrophysical Apparatus, Leningrad). Particle Accel.; 2: No. 4, 313-14 (Oct 1971).

A method for obtaining a beam of relativistic particles with time-increasing energy at a linear accelerator output is described. In particular, energy can be changed at a rate coincident with the acceptance for particle injection into a synchrotron. This allows one to keep optimal conditions for the capture of the relativistic particles during the whole injection period and to accomplish effective multiturn injection. (auth) (UK)

5931 EXPERIMENTS ON THE RECUPERATION OF THE ENERGY OF AN ELECTRON BEAM. Abramyan, E. A.; Sharapa, A. N (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 361-3(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 30-2(Mar-Apr 1971).

Results of experiments on the acceleration, transport, and deceleration of an intense electron beam are presented. The maximum energy of the accelerated electrons was 100 keV, and the maximum current was 25 A. The electrons were decelerated to an energy of 2 keV before hitting the collector. The losses of accelerated electrons did not exceed 0.05%. (auth)

5932 STUDY OF THE ACCELERATION MODES IN LINEAR ION ACCELERATORS BY MEANS OF A SPECTROMETER HAVING A FIXED SETTING. Batalin, V. A.; Kolomiets, A. A.; Kuibida, R. P. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 345-9 (Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 16-20(Mar-Apr 1971).

A method which allows the basic characteristics of the longitudinal motion of particles in a linear ion accelerator to be obtained during one beam-current pulse is described, and results of measurements carried out by this method on the 1–2 linear accelerator which serves as the injector of the proton synchrotron at the Institute of Theoretical and Experimental Physics are given. (auth)

5933 COMPUTER STUDIES OF BEAM DYNAMICS IN A PROTON LINEAR ACCELERATOR WITH SPACE CHARGE. Martini, M.; Prome, M. (Centre d'Etudes Nucleaires, Saclay, France). Particle Accel.; 2: No. 4, 289-99(Oct 1971).

Two computer programs written for investigating space-charge effects in proton linear accelerators are presented. Both use the dynamics equations derived by P. Lapostolle and B. Schnizer (1969): the way these equations have been practically treated is explained. Details are given on the two programs: the first one is based on a particle to particle interaction, while the second one benefits from a continuous equivalent distribution. Results given by both programs are compared and contrasted to previous results (Chasman 1968, 1969). As an application, the problem of the influence of injection energy on linac performance is partially treated. (auth) (UK)

5934 DERIVATION AND SOLUTION OF THE SYSTEM OF EQUATIONS DESCRIBING INTENSE BEAMS, FOR NONSTATIONARY DISTRIBUTION OF TRANSVERSE PHASE-SPACE DENSITY. Kuznetsov, V. S. (Research Inst. of Electrophysical Instrumentation, Leningrad). Particle Accel.; 2: No. 4, 261-8 (Oct 1971).

A system of equations is derived for the dependence of the four-dimensional particle-density distribution function in transverse coordinates and velocities on the longitudinal coordinate of the beam. A numerical solution method is introduced and justified for these equations. (auth) (UK)

5935 INVESTIGATION OF THE DYNAMICS OF CHARGED PARTICLES IN INTENSE BEAMS WITH NONSTATIONARY DISTRIBUTION OF TRANSVERSE PHASE-SPACE DENSITY, BY NUMERICAL EXPERIMENTS. Kuznetsov, V. S.; Kuznetsova, N. P.; Fidel'skaya, R. P.; Solnyshkov, A. I. (Research Inst. of Electrophysical Instrumentation, Leningrad). Particle Accel.; 2: No. 4, 269-78(Oct 1971).

An algorithm and scheme are considered for calculations of transverse phase-space density redistribution, applied to an axially symmetric beam for arbitrary particle-density distribution function in transverse coordinates and velocities. Results of actual calculations are given of the variation in transverse phase-space density distribution for motion of particles of an intense proton beam in a linear accelerator and for motion of the flux of charged particles in a uniform magnetic field. Some characteristics of intense-beam dynamics are explained for nonstationary transverse phase-space density distributions and nonlinear distributions of Coulomb forces. (auth) (UK)

5936 EXPERIMENTAL STUDY ON THE SPACE-CHARGE EFFECT IN PROTON LINACS BY AN ELECTRON MODEL. Okumura, S.; Nishikawa, T.; Yoshikawa, H. (Tokyo Univ.). Particle Accel.; 2: No. 4, 279-82(Oct 1971).

The space-charge effect in proton linacs is experimentally

studied by an electron model. Electrons are accelerated in the first 24 cells of the model cavity which has half-size dimensions of the designed proton linac. The output energy is 1.6 keV which corresponds to 2.8 MeV for protons. The output currents as a function of input currents are measured without changing the other accelerating conditions. A maximum current of 160 μA which is equivalent to a proton current of 300 mA in the space-charge effect is obtained. The output currents show a saturation around this value. These results are explained in terms of the longitudinal space-charge effect. (auth) (UK)

5937 CALCULATION OF PARTICLE ORBITS IN A PRECETRON HAVING AN OFFSET TARGET. Knop, R. E.; Colleraine, A. P. (Florida State Univ., Tallahassee). Contract AT(40-1)-3509. Particle Accel.; 2: No. 4, 301-3(Oct 1971).

The equation of motion of a particle produced in a Precetron with an offset target was studied. These equations were integrated, keeping terms to first order, in a field inhomogeneity parameter. Velocity components r and $r\theta$ were found and were integrated to obtain an expression for $\theta(r^2)$. For this device it is shown that the angle of precession is independent of the target offset. The vertical oscillations are solutions of Mathieu's differential equation and an expression for the motion in the z direction was obtained as a function of r. (auth) (UK)

5938 METHOD FOR THE DESIGN OF AIR-CORE MAGNETS IN TOROIDAL GEOMETRY. Cooper, Richard K.; Beal, Jack W.; Neil, V. Kelvin (Univ. of California, Livermore). Particle Accel.; 2: No. 4, 325-34(Oct 1971).

A method is developed for the design of air-core magnets wound on toroidal surfaces. With the use of toroidal coordinates, it is possible to find the surface current density on a complete torus that will yield any vector potential of the form $\bar{A} = A_\phi(r,z)\hat{\phi}$ inside the torus, where r, ϕ and z are cylindrical coordinates. The function A_ϕ must satisfy the equation $\nabla^2 A_\phi - A_\phi/r^2 = 0$. The surface current density may be chosen such that no net current flows in the azimuthal (ϕ) direction. The surface current is then replaced by a set of conductors, properly located on the toroidal surface. All conductors carry the same current, which flows in the $+\phi$-direction in one-half the conductors and in the $-\phi$-direction in the other half. To construct a magnet of prescribed arc length, the windings can then be connected at the ends to form a continuous current path. Theoretical fields, including the effect of the end windings, are then compared to the measured field of an actual magnet designed by this method. (auth) (UK)

5939 DEVICE FOR REMOTE CONTROL OF THE TURNING AND CHANGING OF TARGETS IN A NUCLEAR-REACTION CHAMBER. Khalin, N. F.; Golovnya, V. Ya.; Shilyaev, V. A. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 370-2(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 38-40(Mar-Apr 1971).

The construction of a device for remote control of the changing of targets and their turning relative to the direction of incidence of a beam of accelerated particles is described. The construction of the device allows the systematic errors connected with the geometry of the experiment to be reduced to a value <1%. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 5583 and 6339.

5940 (CONF-690217-(Ch.2), pp 219-33) OBSERVATION OF SUPER-COLD NEUTRONS. Lushchikov, V. I.; Pokotilovskii, Yu. N.; Strelkov, A. V.; Shapiro, F. L. 1969. (In Russian).

From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Neutrons with velocities of 10 m/sec may be maintained in closed cavities of magnetic "bottles". An experiment involving neutrons moderated by polyethylene is described. The detectors could be cut off alternately with a thin, copper screen which was transparent to neutrons with normal component velocities of a certain value but completely reflected neutrons much less than that value. The results are analyzed with the aid of diffusion theory, and it is shown that ultra-cold neutrons are formed and are propagated in accordance with theoretical expectations. (K.S.W.)

5941 (KAPL-3908) TEMPERATURE DEPENDENCE OF NEUTRON INELASTIC SCATTERING FROM WATER. Esch, L. J.; Moore, W. E.; Seemann, K. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sep 1971. Contract W-31-109-eng-52. 148p. Dep. NTIS.

The neutron inelastic scattering properties of water have been measured at temperatures of 27, 170, and 270°C, using neutrons with incident energies ranging from 0.04 to 0.632 eV, at scattering angles of 10, 14, 25, 40, 60, 90, 120, and 150 deg. A pulsed source of partially thermalized neutrons was provided by the RPI linear electron accelerator (LINAC), an electron-to-neutron converter, and a thin moderator. The LINAC was phased with a high-speed neutron chopper to select the desired neutron energy from the moderator leakage spectrum. The incident and scattered neutron energies were determined by time-of-flight techniques, using multichannel analyzers and an on-line computer. The scattered neutron time-of-flight distribution has been converted to the double-differential scattering cross section, $d^2\sigma/dEd\Omega$, by using other measured integral values of angular distribution and total cross section for water as an internal normalization. The scattering law, $S(\alpha,\beta)$, has also been derived from the data. The experimental resolution function has been measured. The conditions of experimental resolution thus determined, as well as the conditions of multiple-scattering and absorption in the sample, have been imposed on various theoretical models by means of a Monte Carlo computer program. The adjusted models have been compared with data. Comparisons of these results with various theoretical models indicate that the best model is one developed at KAPL in which the water-scattering system is considered as consisting of aggregates of ice-like structures with temperature-dependent sizes, diffusing with a temperature-dependent diffusion constant. The energy levels of the molecules bound in the clusters are represented by a multi-Gaussian frequency distribution, which varies with temperature. The internal vibrations of the individual water molecules are represented by δ functions. (auth)

5942 (LA-4769) TRIANGULAR MESH DIFFERENCE SCHEMES FOR THE TRANSPORT EQUATION. Reed, Wm. H. (Los Alamos Scientific Lab., N. Mex.). Nov 1971. Contract W-7405-eng-36. 11p. Dep. NTIS.

Present transport codes require that the physical system be described by an orthogonal mesh. This restriction leads to the simplest difference schemes but may require that an excessive number of mesh points be used to describe adequately a complicated system. Triangular mesh difference schemes for the transport equation are discussed in this report. These schemes preserve the simplicity of difference schemes on an orthogonal mesh yet permit a much finer representation of complicated geometries, for a given number of mesh cells. Solution of the triangular mesh difference equations is discussed, and the truncation error of these equations is derived. (auth)

5943 (NP-19062) MULTIGROUP NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. Clancy, B. E. (Wollongong Univ. Coll. (Australia)). Oct 1970. 156p. Dep. NTIS.

Thesis.

The multigroup form of the transport equation describing the steady state population of neutrons in a plane geometry is studied. The existing techniques of finding numerical solutions to the transport equation in the discrete ordinate approximation are considered in relation to the deep penetration problem of reactor shielding theory. Some of the computational difficulties are examined and a major one found to be the excessive time used in iterating the equation over a large number of mesh points. A review is given of Chandrasekhar's reflection function method for finding solutions to an astrophysical problem equivalent to the one group form of the deep penetration problem in finite and semi infinite homogeneous media. After generalising the method it is shown how accurate solutions may be obtained for realistic multigroup problems in semi infinite media without the need for spatial iterations. For many deep penetration problems in finite heterogeneous slabs only certain integrals of the angular neutron fluxes emerging from the slabs are of interest. A variational principle is devised with the aid of which solutions to appropriately chosen semi infinite medium problems can be used to calculate directly approximations to any integral of these emerging angular fluxes. From the results obtained with a computer programme embodying these methods it is found that significant savings in computing time can be achieved when a number of survey calculations need to be performed. Some possible applications of the reflection function method to other problems in neutron transport theory are examined briefly. (auth)

5944 (ORNL-tr-2519) ELF NEUTRON PROGRAM. Gervaise, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N-1255. 27p. Dep. NTIS.

The program ELF-NEUTRON makes it possible to study the propagation of neutrons in cylindrical and spherical geometries using cross sections given by the AWRE tape. In the case of a cylindrical geometry, the external contour can be circular or polygonal, the limiting conditions at this contour being either a vacuum, or total reflection. The preparation of the cross sections, the study of the variance, and the drawing of the curves showing the cross sections and the spectra are obtained almost automatically using auxiliary programs. (auth)

5945 (RD/B/N-1834) USER'S GUIDE TO THE MONTE CARLO NEUTRONICS PROGRAM EGMONT. Johnson, P. W. (Central Electricity Generating Board, Berkeley (England), Berkeley Nuclear Labs.). Jan 1971. 31p. Dep. NTIS (U. S. Sales Only).

The many-energy-group variable-lattice-geometry Monte Carlo code EGMONT was translated, with improvement, for the CEGB system 360 computer. The code is described from the point of view of potential users. A major part of any application of this code is the setting up of nuclear data. The UKAEA code MOULD, part of the DICE scheme, was used for the nuclear data preparation. This has been translated and comprehensive user instructions are given. During the translation and early application of EGMONT to specific problems a number of potential improvements to the coding, geometry and tracking were identified and are recommended for implementation. (auth) (UK)

5946 (TID-25736(Suppl.1)) CINDA 71: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA, Supplement 1. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). 1 Jun 1971. 245p. Dep. NTIS. IAEA.

Information added to the CINDA library since the publication of CINDA 71 is presented. (R.W.R.)

5947 COLD NEUTRON SOURCE EFFICIENCY IN A TANGENTIAL BEAM HOLE. Dimic, V.; Petkovsek, J. (Inst. Jozef Stefan, Ljubljana, Yugoslavia). Nucl. Instrum. Methods; 96: No. 2, 285-8(1971).

Cold neutron beam intensity has been measured for differently shaped moderator chambers at different positions in a 15 cm diameter tangential beam hole of the reactor Triga Mark II. Measurements have been performed at ambient temperatures. It has been found that the most favorable configuration for a moderator is a "black body" scatterer with a gain factor of 19 relative to the empty beam hole and of 1.7 relative to the 15 cm long graphite slab. (auth)

5948 INTENSITY ESTIMATION FOR A NEUTRON BEAM FOR BIOLOGICAL AND MEDICAL APPLICATIONS. Goebel, K.; Miller, A. J. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 96: No. 4, 581-7(1971).

Fast neutrons of energies in the multi-MeV region are of great interest for biological and medical applications because of their special type of interaction with tissue-like material. The neutron

energy is delivered to the tissue by one or several of the following means: (a) recoil protons, (b) recoil heavy particles, (c) nuclear disintegration, and (d) low-energy protons from neutron reactions with nitrogen and γ rays from neutron capture in hydrogen. Intensity estimations for different types of neutron beams based on averaged and interpolated values from published and unpublished sources are discussed. In making the estimates, realistic values were assumed for the distance from neutron source to exposure area. This assumption is necessary for two reasons: (a) to allow for the installation of sufficient shielding to reduce the background radiations in the irradiation area, and (b) to allow for neutron beam divergence so that reasonably large objects can be irradiated uniformly. (auth)

5949 FABRICATION OF THIN FLAT COBALT MIRRORS FOR THE POLARIZATION OF THERMAL NEUTRONS. Shatlovskaya, N. S.; Beketov, V. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 2, 618-19(Mar-Apr 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 2, 247-9(Mar-Apr 1971).

A method of fabricating thin flat cobalt mirrors on a glass base which allows an electrolytic layer of β-Co having a maximum magnetic permeability to be obtained is described. The characteristics of the mirrors and of a neutron polarizer fabricated using them are given. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 5706, 5716, 5717, 5759, 5834, 5899, 5902, 6019, 6078, 6127, and 6146.

5950 (FEI-225) NEUTRONS FROM THICK TARGETS BOMBARDED BY PROTONS AT 11.5 MeV. Daruga, V. K.; Matusevich, E. S.; Vozyakov, V. V.; Dulin, V. A. 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

Neutron spectra, absolute yields, and angular distributions from thick targets of Be, C, Al, Ti, Nb, Ta, Bi, and U bombarded by protons with an energy of 11.5 ± 0.5 MeV were measured. (J.F.P.)

5951 BREMSSTRAHLUNG IN DEUTERON–PROTON SCATTERING. Hall, J.; Woelfli, W.; Mueller, R. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 37B: No. 1, 53-4 (1 Nov 1971).

An experiment to determine the bremsstrahlung cross section in deuteron–proton scattering was performed for incident deuteron energies of 7.0, 8.0, and 9.0 MeV. It was verified that the contribution of the so-called rescattering effect is negligible in this case. (auth)

5952 MODEL CALCULATION IN THE BINDING ENERGY OF ^{4}He. Galbraith, H. W. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 37B: No. 1, 1-3(1 Nov 1971).

The method of 9-dimensional harmonics is applied to a calculation of the binding energy of the symmetric-boson 4-body system as a model of the α particle. Square-well 2-body potentials fitted to nuclear parameters are used. (auth)

5953 ELASTIC n–^{4}He SCATTERING AS FIVE BODY PROBLEM. Efros, V. D.; Zhukov, M. V. (Atomic Energy Inst., Moscow). Phys. Lett.; 37B: No. 1, 18-20(1 Nov 1971).

The method of solving problems of continuous spectrum in the few-nucleon system is considered. The elastic scattering n–^{4}He in p-wave is calculated. (auth)

5954 VARIATIONAL CALCULATION OF COUPLING CONSTANTS BETWEEN NUCLEAR SPINS. Paviot, Jacques; Hoarau, Jean (Bordeaux Univ., Talence, France). Compt. Rend., Ser. C; 272: No. 20, 1718-20(17 May 1971). (In French).

The Fermi contact term was calculated by the variation method. The procedure consists of minimizing the self-coupling energy. The parameters thus determined are used to evaluate the coupling constant. This method is applied to the calculation of the coupling constant of deuterated hydrogen. (France)

5955 MEASUREMENT OF THE ROTATION PARAMETER R IN PROTON–DEUTERON SCATTERING. Stewart, N. M. (London Univ.); Gibson, W. R.; Megaw, J. H. P. C. Nucl. Phys.; A174: No. 2, 338-42(1971).

Measurements of the rotation parameter R were made for the elastic scattering of 48.3 MeV polarized protons from liquid deuterium in the angular range 40 to 70° lab. (auth)

5956 PHASE-SHIFT ANALYSIS OF PROTON–DEUTERON ELASTIC SCATTERING AT E_p = 6.78 MeV. Groetzschel, R.; Kuehn, B.; Kumpf, H.; Moeller, K.; Moesner, J. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A174: No. 2, 301-11(1971).

Differential cross sections for the elastic scattering of protons by deuterons have been measured for angles from 13.5 to 162° in c.m.s. by bombarding a deuterized polyethylene target with 6.78 MeV protons. The median uncertainty of all measured points is about ±1%. A phase-shift analysis of the measured angular distribution has been performed. Special attention was paid to the question of errors and correlations of the determined phase shifts. (auth)

5957 ELASTIC SCATTERING REACTIONS ^{4}He(t,t)^{4}He AND ^{4}He(τ,τ)^{4}He NEAR 2 MeV. Chuang, L. S. (Chinese Univ. of Hong Kong). Nucl. Phys.; A174: No. 2, 399-407(1971).

A Van de Graaff accelerator and a nickel foil isolated gas scattering chamber are used for elastic scattering of tritons and τ-particles by ^{4}He. Angular distributions are measured for E_t = 2.98, 2.46 and 2.13 MeV, and E_τ = 2.98, 2.46 and 1.72 MeV over an angular range from 34.9° to 136.9° in the c.m. system. Computer extraction of the phase shifts using the partial waves up to l = 1 is undertaken. Comparisons of the present results with the available published results are made. A new method of beam collection by a Faraday cup in the target gas is attempted. The method is correct to ±4% under the present experimental conditions. (auth)

5958 TOTAL CROSS SECTION OF PROTONS FOR 2.5-MeV NEUTRONS. Davis, J. C. (Univ. of Wisconsin, Madison); Weaver, K. A.; Hilscher, D.; Barschall, H. H.; Smith, A. B. Phys. Rev., C; 4: No. 4, 1061-9(Oct 1971).

The total cross section of protons for neutrons of mean energy 2535 keV was measured to be 2536 ± 4 mb. This measurement is the average of determinations with five different hydrocarbon samples. Special care was taken to measure neutron energy accurately throughout the experiment and to keep corrections for background and inscattering very small. The singlet effective range deduced from this measurement is 2.78 ± 0.07 fm and is consistent with values deduced from proton-proton scattering under the assumption of charge independence of nuclear forces. (auth)

5959 SEARCH FOR A STATE IN ^{3}He VIA THE p + D → p + d* REACTION. Braithwaite, W. J.; Cameron, J. M.; Storm, D. W.; Trombrello, T. A. (Univ. of Washington, Seattle). Phys. Rev., C; 4: No. 4, 1476-80(Oct 1971).

Excitation functions for the ^{2}H(p,pp)n reaction have been measured at pairs of proton angles chosen so that the p-n system with zero relative energy was at 30 and 90° in the cm system. The differential cross sections $d\sigma/d\Omega_1 d\Omega_2$ corresponding to the production of a p-n system with relative p-n energy below 100 keV are presented. The excitation functions cover the incident proton energy range of 7 to 14.5 MeV in 0.5-MeV steps. The energy dependence of the primary interaction has been extracted by using final-stage modifications of the Watson type. No evidence was found for structure in either the excitation function for the differential cross section or in the excitation function for the primary interaction factor. (auth)

5960 MASSES OF H, D, ^{16}O, AND ^{32}S DETERMINED WITH LARGE-DISPERSION MASS SPECTROMETER. Matsuda, H.; Fukumoto, S.; Matsuo, T. (Osaka Univ.). pp 477-81 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The atomic masses of H, D, ^{16}O, and ^{32}S were measured using a large-dispersion mass spectrometer. The ^{40}Ca–^{40}Ar mass difference was also measured. The second-order aberration coefficients were determined in the process of focusing the spectrometer. (J.W.R.)

5961 RECENT MASS DETERMINATIONS WITH THE ARGONNE 100-INCH-RADIUS MASS SPECTROMETER. Stevens, C. M.; Moreland, P. E. Jr. (Argonne National Lab., Ill.). pp 1296-1300 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Precise measurements of the masses of H, D, ^{35}Cl, and ^{37}Cl have been made with the Argonne 100″ radius mass spectrometer. The values are H = 1.007825055 ± 40, D = 2.01410176 ± 20, ^{35}Cl = 34.96885275 ± 30 and ^{37}Cl = 36.96590334 ± 30. (auth)

5962 PROCEEDINGS OF THE BANFF SUMMER SCHOOL ON INTERMEDIATE ENERGY NUCLEAR PHYSICS, BANFF, ALBERTA, CANADA, AUGUST 17–28, 1970. Neilson, G. C.; Olsen, W. C.; Varma, S. (eds.). Edmonton, Alberta; University of Alberta (1970). 446p.

Separate abstracts were prepared for each of the 22 papers in this volume. (R.W.R.)

For abstracts of individual papers see: 4591, 5693, 5716, 5717, 5769, 5788, 5835, 5836, 5847, 5920–5923, 5963–5965, 6002, 6103–6105, 6145, and 6146.

5963 HIGH ENERGY PROTON NUCLEUS SCATTERING. Palevsky, H. (Brookhaven National Lab., Upton, N. Y.). pp 198-239 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

An experimental study of the interaction of 1 GeV protons with nuclei is described. The first lecture is devoted mainly to the equipment, consisting of wire spark chambers and a high resolution magnetic spectrometer. The data on p–^{16}O, p–^{4}He, and p–^{12}C elastic scattering and the (p,d) reaction with ^{16}O, ^{6}Li, and ^{4}He are presented and interpreted in the remaining lectures. (L.B.S.)

5964 QUASI-ELASTIC SCATTERING AND SHORT RANGE CORRELATIONS. Perdrisat, C. F. (Virginia Associated Research Campus, Newport News). pp 369-84 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmoton, Alberta; Univ. of Alberta (1970).

Ways in which short-range correlations might modify single-particle wave functions are illustrated. Short-range correlations and the nuclear single- and two-particle densities are first defined ^{4}He elastic electron scattering data are then fitted by using a Jastrow ground-state density. Then the momentum distribution deduced from ^{4}He(p,2p) data is discussed, under the assumption that the plane-wave impulse approximation is valid. By Fourier-transforming the results a radial distribution is obtained which has approximately the correct root-mean-square radius, has an $e^{-\alpha r}/r$ behavior for $r > 2F$, and might show a slight depression for $r < 1$ F when compared with the best harmonic oscillator fit. (R.W.R.)

5965 BROAD RESONANCES IN THE THREE-NUCLEON SYSTEM. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 393-5 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The reactions ^{3}H(p,n)^{3}He and ^{3}He(p,n)3p have been studied at 30 and 50 MeV. Four-body phase-space calculations fitted the latter reaction at large angles, but not at small angles. After subtraction of the phase space the spectra display a broad peak centered around 9 MeV excitation with a width of approximately 10 MeV (fwhm). The excitation and width are independent of the angle of observation. For the former reaction two broad peaks are required to fit the data; they are centered at 10 and 16 MeV and have widths of 11 and 9 MeV. Since Q values and widths are independent of the angle of observation, they are attributed to broad resonances in the three-nucleon system. The reaction ^{3}He(π^-, π^+)3n was studied at 140 MeV. The data have been fitted in terms of a Breit–Wigner resonance of excitation 2 MeV with a width of 12 MeV. Calculations using soft-core two-nucleon potentials and a variational technique have been able to fit the data fairly well. (R.W.R.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 5537, 5538, 5717, 5899, 5950, 5960, 5963, 5964, 6019, 6040, 6055, 6058, 6075, 6078, 6103, 6104, 6107, 6108, 6110, 6128, and 6146.

5966 (ANL–7837) HEAVY-ION SCATTERING. Proceedings of the Symposium held at Argonne National Laboratory, March 25–26, 1971. (Argonne National Lab., Ill.). Mar 1971. 321p. (CONF-710327). Dep. NTIS.

Separate abstracts were prepared for each of the 16 papers in this symposium. (R.W.R.)

For abstracts of individual papers see: 5967–5974, 6003, 6004, 6107–6112.

5967 (ANL–7837, pp 53-6) ADIABATIC ENERGY SURFACE FOR ^{12}C + ^{12}C. Thomas, T. D.; Riesenfeldt, P. W. (Princeton Univ., N. J.). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The two-center model is used to calculate the adiabatic energy surface for the interaction of ^{12}C with ^{12}C. There is no evidence for a secondary minimum that would give rise to quasi-molecular states, and the adiabatic potential is fairly shallow. The overall shape of the surface is dominated by a strongly attractive nuclear force and a weakly repulsive Coulomb force. It is concluded that the quasi-molecular phenomena found near the barrier for ^{12}C incident on ^{12}C arise not from a local minimum but rather from the dynamics of the process. (R.W.R.)

5968 (ANL–7837, pp 57-61) PRELIMINARY RESULTS ON A TEST FOR CORRECTNESS OF AN ION–ION POTENTIAL. Purser, K. H.; Gaarde, C.; Gove, H. E.; Kubo, H.; Liebert, R. (Rochester Univ., N. Y.). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The correctness of certain ion–ion potentials was tested by studying the coincident alpha particles produced during an ^{16}O + ^{16}O collision at 60 MeV. Alpha-particle and missing-mass spectra are given; the latter spectrum shows that a number of known states in ^{24}Mg are strongly populated. The model predicts a maximum coincidence intensity at certain angles; no evidence for this peaking was found. (R.W.R.)

5969 (ANL–7837, pp 63-101) SURVEY OF HEAVY-ION SCATTERING STUDIES AT YALE. Gobbi, Adriano (Yale Univ., New Haven, Conn. Nuclear Structure Lab.). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

Angular distributions and excitation functions for heavy-ion scattering are analyzed in an optical-model framework. Emphasis is placed on identical-particle systems, in particular, ^{16}O + ^{16}O. A study of the behavior of the phase shifts shows that it is possible to identify specific energy and angular behavior of the elastic channels with particular partial waves; however, the classical resonance behavior is masked by the absorption present. Coupled-channels calculations in which the inelastic and neutron-transfer channels are included are then considered. The instrumentation system is briefly described; and rather detailed data on angular distributions are given for the systems ^{12}C + ^{12}C at 20 to 30 MeV (cms), ^{12}C + ^{13}C at 7.8 to 20.8 MeV (cms), and ^{24}Mg + ^{24}Mg at 17.37 to 25.00 MeV (cms). (R.W.R.)

5970 (ANL–7837, pp 103-19) ELASTIC AND INELASTIC SCATTERING STUDIES AT THE UNIVERSITY OF WASHINGTON. Vandenbosch, R. (Washington Univ., Seattle). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

Study of the ^{16}O + ^{16}O excitation function [Siemssen et al., Phys. Rev. Lett., 19: 369 (1967); ibid., 20: 175 (1968); Maaer et al., Phys. Rev., 188: 1665 (1969)] by fluctuation analysis and coupled-channels calculations indicates that there is no unambiguous evidence for intermediate structure. The ^{18}O + ^{18}O excitation function from 10 to 27 MeV was measured. This is analyzed by a modified optical model in which the absorptive part of the optical potential is considered to be a function of angular momentum as well as radius. A coupled-channels calculation is also presented. To explore the effects of coupling to inelastic channels on the elastic channel further, an analysis of the ^{16}O + ^{18}O reaction, for which there are data for both the elastic and inelastic scattering to the 2^+ state, is presented. The effects of angular momentum are also explored in the scattering of ^{16}O by ^{40}Ca and ^{48}Ca. (R.W.R.)

5971 (ANL–7837, pp 121-43) VALENCE NUCLEONS IN THE SCATTERING OF HEAVY IONS (AND SURVEY OF EXPERIMENTS AT HEIDELBERG). von Oertzen, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

In the elastic scattering of two nonidentical nuclei there always exists a certain probability for the transfer of the difference of the two nuclei. This process adds coherently to the potential scattering and can strongly influence the angular distributions of elastic scattering. A theoretical description of molecular scattering states in the scattering of nuclei by nuclei is given. Angular distributions are shown and analyzed for the following cases: ^{12}C + ^{13}C at 15 MeV, ^{14}N + ^{12}C at 20 to 27.3 MeV, ^{14}N + ^{13}C at 9.65 MeV (cms), ^{13}C + ^{14}C at 15 and 19 MeV, ^{14}N + ^{14}C and ^{14}N + ^{16}O at 20 and 25 MeV, and α + ^{6}Li and α + ^{7}Li at 2.5 to 4.5 MeV. The elastic scattering excitation function is also given for the alpha scattering. The paper concludes with a discussion of parameters of the complex potential and the adiabatic molecular energy. (R.W.R.)

5972 (ANL–7837, pp 145-86) HEAVY-ION SCATTERING STUDIES AT ARGONNE. Siemssen, R. H. (Argonne National Lab., Ill.). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

An optical-model analysis of heavy-ion scattering is presented with the purpose of studying the validity of various models. Excitation functions are presented for the following systems and en-

ergies: $^{6}Li + {}^{6}Li$ at 5 to 17 MeV, $^{16}O + {}^{14}N$ at 13 to 27 MeV, $^{16}O + {}^{15}N$ at 13 to 26 MeV, $^{16}O + {}^{16}O$ at 13 to 32 MeV, $^{24}Mg + {}^{16}O$ at 18 to 32 MeV, $^{26}Mg + {}^{16}O$ at 20 to 32 MeV, $^{28}Si + {}^{16}O$ at 22 to 36 MeV, $^{30}Si + {}^{16}O$ at 22 to 33 MeV, $^{16}O + {}^{12}C$ at 8 to 26 MeV, and $^{16}O + {}^{16}O$ at 10 to 35 MeV. In addition, angular distributions are given for the above scatterings involving ^{16}O, ^{26}Mg, and ^{12}C, as well as for $^{28}Si + {}^{14}N$, $^{28}Si + {}^{15}N$, and $^{28}Si + {}^{16}O$ at approximately 40 and 50 MeV. It was found that parameters which seemingly yield acceptable fits to angular distributions (even at several energies) more often than not fail to reproduce the excitation functions, whereas parameters that fit the excitation functions usually also give an acceptable description of the angular distributions. The fact that the data for $^{16}O + {}^{16}O$ scattering are consistent with a black nucleus for the low-l partial waves precludes use of these data to infer anything about a repulsive core; it is meaningless to talk of a repulsive core if the particles disintegrate before they have a chance to feel the effects of the core. Both weakly and strongly absorbing potentials are considered; it is concluded that the ambiguities of the weakly absorbing potentials are not well understood. Elastic transfer in $^{12}C + {}^{16}O$ scattering was also investigated; very little evidence for strong contributions from this process was found. (R.W.R.)

5973 (ANL-7837, pp 195-8) $^{16}O(^{16}O, {}^{16}O)^{16}O^*$ AND $^{16}O(^{16}O, {}^{12}C)^{20}Ne^*$ REACTIONS. Singh, P. P.; Sink, D.; Schwandt, P. (Indiana Univ., Bloomington); Malmin, R. E.; Siemssen, R. H. (Argonne National Lab., Ill.). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

Excitation functions and angular distributions from the reaction $^{16}O(^{16}O, {}^{12}C)^{20}Ne$ are reported for energies between 18 and 30 MeV (cms) and angles between 50 and 90°. A prominent, resonance-like structure ~1.5 MeV in width was found in the excitation functions of the 4.3-MeV transition. Angular distributions measured at energies just below, on, and above the "resonance" are featureless and thus preclude diffraction as a possible explanation. (R.W.R.)

5974 (ANL-7837, pp 303-8) PARAMETRIZED PHASE SHIFT ANALYSIS OF THE $^{16}O-{}^{16}O$ ELASTIC SCATTERING. Voit, H.; Helb, H.-D.; Ischenko, G.; Siller, F. (Erlangen-Nuernberg Univ. (West Germany). Physikalisches Institut). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The experimental angular distributions and excitation functions for $^{16}O-{}^{16}O$ elastic scattering at 10 to 35 MeV are described by an almost constant set of parameters in the framework of the McIntyre model modified by an additional hump. The set of parameters is unambiguous, and both magnitude and phase of the partial wave amplitudes show no irregularities. The structure in the excitation functions is reproduced fairly well, but the cross section is too large at energies above 32 MeV. It is found that the l = 12 partial wave is responsible for the gross structure between 19 and 22 MeV in the 90° excitation function, and that this excitation function can be reproduced with the modified McIntyre model with an energy-independent r-space parametrization of the smooth cutoff and an energy-dependent position parameter of the hump. (R.W.R.)

5975 (FRNC-TH-110) ABSORPTION AND DOUBLE CHARGE EXCHANGE OF π MESONS BY LIGHT NUCLEI. Massue, J. P. (Strasbourg Univ. (France). Faculte des Sciences). 3 Nov 1971. 135p. (In French). Dep. NTIS (U. S. Sales Only).

The absorption of π^- mesons by light nuclei (^{12}C, ^{16}O and ^{14}N) was experimentally studied. A nuclear emulsion technique was used and cases where the stars formed have a hammer track were considered. Most π^- mesons were absorbed by ^{4}Li clusters, the others being absorbed by 2 or 3 nucleons. The absorption and double charge exchange of 60-MeV π^+ was investigated. The results obtained with ^{12}C were theoretically analyzed in order to determine the nature of the structure which absorbs the meson. Two cases were envisaged: either a quasi-deuteron or a nucleon correlated with another nucleon. Double charge exchange reactions with C nuclei were investigated using a propane bubble chamber and results from nuclear emulsions. Clusters (particularly α clusters) are shown to play an important part in the nucleus. (France)

5976 (JINR-P1-5977) CHARGED PARTICLES FROM THE CAPTURE OF NEGATIVE PIONS BY NUCLEI. Budyashov, Yu. G.; Zinov, V. G.; Kohin, A. D.; Rabin, N. V.; Chatrchyan, A. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

The energy spectra and the relative probability of emission were measured for protons, deuterons, and tritons which were released during the absorption of 15- to 24-MeV negative pions by the following nuclei: ^{9}Be, ^{12}C, ^{27}Al, ^{32}S, ^{40}Ca, ^{64}Cu, ^{114}Cd, and ^{208}Pb. (tr-auth)

5977 THIRD-ORDER CALCULATION OF THE ^{16}O BINDING ENERGY AND OF THE SINGLE-PARTICLE ENERGIES OF ^{17}O. Kassis, N.; Mavromatis, H. A.; Singh, B. (American Univ., Beirut). Phys. Lett.; 37B: No. 1, 15-17(1 Nov 1971).

The third-order contribution to the binding energy of ^{16}O is shown to be small and of opposite sign to the second-order contribution. By contrast, third-order contributions to the single-particle energies of ^{17}O are relatively more important than, though again of opposite sign to, the second-order contributions. Third-order contributions improve both the spin-orbit splitting and l spacing in ^{17}O. (auth)

5978 SHELL-MODEL CALCULATION OF THE MASS 18 NUCLEI AND THE EFFECTIVE INTERACTION IN THE sd-SHELL. Lo Iudice, N.; Rowe, D. J.; Wong, S. S. M. (Univ. of Toronto). Phys. Lett.; 37B: No. 1, 44-6(1 Nov 1971).

A shell-model calculation of the energy levels of ^{18}O and ^{18}F is performed in the 2-particle and 3-particle-1-hole configuration space by using the bare G-matrix elements of Kuo and Brown. The objective is to test the convergence of perturbative calculations of the effective interaction. The results are compared with those of first-order perturbation theory, and are found to be generally similar. (auth)

5979 NEGATIVE-PARITY STATES IN ^{16}O POPULATED IN THE $^{12}C(^{6}Li,d)^{16}O$ REACTION. Artemov, K. P.; Goldberg, V. Z.; Petrov, I. P.; (and others) (Inst. of Atomic Physics, Moscow). Phys. Lett.; 37B: No. 1, 61-4(1 Nov 1971).

From a study of the reaction $^{12}C(^{6}Li,d)^{16}O(\alpha)^{12}C$, spins and parities were measured for states in ^{16}O at the excitation energies 14.6 (5^-), 16.2 (6^+), and 20.8 (7^-) MeV. These states were found to undergo α-particle decay, predominantly (≈90%) to the ground state of ^{12}C. The results obtained show that the $^{12}C(^{6}Li,d)^{16}O$ reaction populates in ^{16}O negative-parity as well as positive-parity rotational bands. (auth)

5980 5^- RESONANCE IN THE $^{16}O(\alpha,\gamma)^{20}Ne$ REACTION AT E_α = 4.65 MeV. Rogers, D. W. O.; Allen, K. W.; Evans, H. C.; (and others) (Nuclear Physics Lab., Oxford). Phys. Lett.; 37B: No. 1, 65-7(1 Nov 1971).

A resonance at E_α = 4647 keV in the $^{16}O(\alpha,\gamma)^{20}Ne$ reaction was located and assigned to a 5^- state in ^{20}Ne at 8447 ± 3 keV. The radiative width of the 5^- to 3^- transition was measured and found to be 13 ± 3 MeV corresponding to a transition strength of 26 ± 6 Weisskopf units. Comparisons are made with rotational and shell-model predictions. (auth)

5981 SPECTRA AND APPLICATION OF WHITE NEUTRONS FROM DEUTERON BOMBARDMENT OF BERYLLIUM. Cranberg, L.; Barnett, J. P.; Cramer, D. S.; Wilson, R. D. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 96: No. 4, 493-6(1971).

Data are reported on the spectra of neutrons produced by bombardment of a thick beryllium target by pulsed deuterons of 5.2 MeV energy at several angles of observation. The neutrons produced at 45° are used to measure the transmission of carbon and polyethylene samples to illustrate application of the neutron source to the measurement of nuclear excitation functions in the energy range below 8.5 MeV, using time-of-flight monochromatization. Comparisons with other systems are discussed. (auth)

5982 MEASUREMENTS OF THE $^{16}O(p,2p)^{15}N$ ANGULAR CORRELATION AT 45 MeV. Eisberg, R. M. (Univ. of California, Santa Barbara); Ingham, D.; Makino, M.; Kim, C. C.; Waddell, C. N. Contracts AT(11-1)-34; AT(04-3)-136. Nucl. Phys.; A175: No. 1, 58-64(1971).

The angular correlation between protons from the ground state $^{16}O(p,2p)^{15}N$ reaction, induced by 45 MeV protons, has been measured for protons emitted with equal energies at symmetric, coplanar angles from 20°-20° to 90°-90°. These data were obtained to provide a test for the various procedures used for distorted-wave analysis of (p,2p) reactions in an energy region where optical-model distortion effects play a dominant role. Comparison is made to previous measurements of the $^{14}N(p,2p)^{13}C$ reaction at 45 MeV. The angular distributions are very similar in shape and differ in magnitude by an amount in agreement with the pertinent spectroscopic factors measured in (d,^{3}He) pick-up reactions. (auth)

5983 PRODUCTION OF ^{7}Be BY 7 GeV PROTON INTERACTIONS WITH OXYGEN. Stapleton, G. B.; Thomas, R. H. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; A175: No. 1, 124-8(1971).

The cross section for ^{7}Be production by 7 GeV proton interactions with oxygen has been measured and found to be 9.1 ± 0.5 mb

(with an absolute accuracy better than 20%). A comparison with other published data is made. (auth)

5984 SOME ONE-NEUTRON TRANSFER REACTIONS WITH ^{18}O AND ^{19}F BEAMS. Knoth, H.; Barker, P. H.; Huber, A.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A172: No. 1, 25-32(1971).

The differential cross sections of the neutron transfer reactions $^{13}C(^{18}O,^{19}O)^{12}C$, $^{9}Be(^{18}O,^{19}O)^{8}Be$, $^{9}Be(^{18}O,^{17}O)^{10}Be$, $^{10}B(^{19}F,^{18}F)^{11}B$, and $^{10}B(^{18}O,^{17}O)^{11}B$ have been measured at energies in the region of the Coulomb barrier. Using a DWBA formalism, the products of the involved neutron spectroscopic factors have been extracted. (auth)

5985 STATES IN ^{10}B BETWEEN 18 AND 22 MeV. Ling, S. C.; Blatt, S. L. (Ohio State Univ., Columbus). Nucl. Phys.; A174: No. 2, 375-84(1971).

Existing data on four resonances seen in $^{7}Li + \tau$ reactions have been re-examined, and additional measurements of the reaction $^{7}Li(\tau,\gamma)^{10}B$ have been made, in order to better establish the spins and parities of the ^{10}B compound states involved. The excitation energies of these states and their most likely assignments are: 18.4 MeV, 2^-; 18.8 MeV, $(1^+,2^+)$; 19.3 MeV, 2^-; and 20.2 MeV, 1^- All appear to be T = 1 states. (auth)

5986 MIXING OF ^{13}N LEVEL CONFIGURATIONS FROM THE $^{11}B(\tau,n)^{13}N$ REACTION. Hsu, T. H.; Honsaker, J. L.; McDonald, W. J.; Neilson, G. C. (Univ. of Alberta, Edmonton). Nucl. Phys.; A174: No. 2, 365-74(1971).

Angular distributions from the reaction $^{11}B(\tau,n)^{13}N$ for levels of ^{13}N below 10.5 MeV excitation have been measured at bombarding energies of 4.7, 6.1 and 6.49 MeV. Analysis has been carried out by a combination of Hauser–Feshbach and DWBA calculations. The results are interpreted in terms of 2-proton transfers into shell-model orbits. Data for levels of ^{13}N at 0.0, 3.50 and 9.48 MeV are very well fitted by assuming 90% or more 1p shell structure. That for the 7.36 MeV level is fitted assuming a nearly pure 1f single-particle state. Also, good fits are obtained by assuming the 10.38 MeV $5/2^+$ level is 50% 1f and the 11.88 MeV level is 20% 2p when the remainder is taken as 1p structure. The even-parity level at 2.37 MeV has an angular distribution consistent with a single 2s proton outside a ^{12}C core. The differential cross sections for the even-parity levels at 6.35, 6.88 and 7.15 MeV are within a factor of two of the Hauser–Feshbach predictions. (auth)

5987 REACTION $^{11}B(p,3\alpha)$ AT 163 keV. Kong-A-Siou, D.; Giorni, A. (CEN, Grenoble, France). Nucl. Phys.; A174: No. 2, 312-20(1971). (In French).

With four detectors in the horizontal plane, three biparametric spectra (128 × 128 channels) were measured simultaneously. Nine geometries were studied covering the majority of the Dalitz plot while one detector was fixed at $\theta = 90°$. The results have been interpreted taking account of the two mechanisms: (i) $^{11}B + p \rightarrow {}^{12}C(2^+) \rightarrow \alpha + {}^{8}Be(0^+,2^+)$ with $^{8}Be \rightarrow 2\alpha$, and (ii) $^{11}B + p \rightarrow {}^{12}C(2^+) \rightarrow 3\alpha$. The reaction mechanism is principally of type (i). Excellent agreement with the experimental results can be obtained by choosing s = 1, l = 1 for the p-^{11}B channel and s = 2, l = 2 for the α-^{8}Be channel. (auth)

5988 VECTOR ANALYZING POWER OF $(\vec{d},n)$ REACTIONS ON ^{11}B, ^{12}C, ^{14}N, AND ^{15}N. Hilscher, D.; Davis, J. C.; Quin, P. A. (Univ. of Wisconsin, Madison). Nucl. Phys.; A174: No. 2, 417-25 (1971).

The vector analyzing power of $(\vec{d},n)$ reactions on ^{11}B, ^{12}C, ^{14}N and ^{15}N was measured for laboratory angles between 2.5° and 70°. A deuteron energy of 8.5 MeV was used for the $^{12}C(\vec{d},n_0)^{13}N$ reaction. The $^{11}B(\vec{d},n_0)^{12}C$, $^{11}B(\vec{d},n_1)^{12}C$, $^{14}N(\vec{d},n_0)^{15}O$, and $^{15}N(\vec{d},n_0)^{16}O$ reactions were studied at deuteron energies of 10.0 and 11.8 MeV. The vector analyzing power of the $j = 1/2$ and l = 1 transitions to the ground states of ^{13}N and ^{16}O shows a similar characteristic j-dependence as has been found for (d,p) reactions on intermediate and light-weight nuclei with the same j- and l-value. For the $^{11}B(d,n_1)^{12}C$ and $^{14}N(d,n_0)^{15}O$ reactions j_p is predominantly $1/2$. Results of distorted-wave calculations are in reasonable agreement with the measurements. (auth)

5989 $^{12}C(^{13}C,\alpha)$ TRANSITIONS TO POSSIBLE EIGHT-PARTICLE, THREE-HOLE STATES IN ^{21}Ne. Middleton, R.; Garrett, J. D.; Fortune, H. T.; Betts, R. R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 27: No. 19, 1296-9 (8 Nov 1971).

Excitation functions and energy-averaged angular distributions were measured for the $^{12}C(^{13}C,\alpha)$ transitions to the 3.66- and 3.89-MeV states in ^{21}Ne. The similarities observed between these transitions and the $^{12}C(^{12}C,\alpha)$ transition to the 7.83-MeV 2^+ eight-particle–four-hole state in ^{20}Ne suggest a possible eight-particle–three-hole configuration for the 3.66- and 3.89-MeV states of ^{21}Ne. (auth)

5990 BOUND-PION ABSORPTION BY ^{12}C AND NUCLEAR SHORT-RANGE CORRELATIONS. Morris, J. W. Jr.; Weber, H. J. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 27: No. 19, 1299-1302(8 Nov 1971).

The absorption of stopped negative pions by ^{12}C inducing nucleon pair emission is studied. The three-body final-state scattering includes a two-body residual interaction and an optical potential. Agreement of this model with experiment cannot be obtained without including Jastrow-type short-range correlations with dominant momentum components between 0.3 and 0.4 GeV/c. (auth)

5991 RADIATIVE PROTON CAPTURE INTO ^{14}N. Riess, F. (Stanford Univ., Calif.); O'Connell, W. J.; Paul, P. Nucl. Phys.; A175: No. 3, 462-80(1971).

The reactions $^{13}C(p,\gamma_{1,2})^{14}N$ and $^{13}(p,p'\gamma(3.09, 3.68, 3.85))^{13}C$ were studied for $E_p = 3.0$ to 18 MeV, which covers the giant dipole resonance in ^{14}N. Below $E_p = 7.0$ MeV, resonances in the γ_0 yield were found at $E_p = 3.771$ MeV ($\Gamma_{c.m.} \leqq 2$ keV), 4.53 (115 ± 10), 5.32 (48 ± 7), and 6.2 (1000 ± 150), which correspond to excitation energies of 11.049, 11.74, 12.485, and 13.3 MeV, respectively. From the angular distribution, $J^\pi = 2^+$, 3^+ was established for the 11.049-MeV state, which is thus a newly found excited state of ^{14}N. In all other cases cross correlations exist with states reported in other reactions. The 13.3-MeV state is thought to be part of the giant dipole resonance. Above 7 MeV bombarding energy the (p,γ_0) yield shows broad structure and the giant dipole resonance with two peaks at 22.5 and 23.0 MeV excitation energy. All peaks can be related to structure observed in the inverse photonuclear (γ,p_0) reaction. The inverted (p,γ_0) cross section exhausts 18% of the classical dipole sum rule between 12 and 24 MeV. Angular distributions indicate that most of the GDR up to 24 MeV is related to $J^\pi = 2^-$ states, in accordance with theoretical predictions. The (p,γ_1) yield to the $J^\pi = 0^+$, T = 1 state in ^{14}N averages only $1/5$ of the γ_0 yield, and no giant resonance structure is evident up to 24 MeV. The expectations for the T = 0 GDR based on the 2.3-MeV state are discussed. It is suggested that two narrow resonances seen at excitation energies of $E_x = 23.7$ MeV ($\Gamma_{c.m.} \approx 500$ keV) and 24.2 MeV ($\Gamma_{c.m.} \approx 100$ keV) are the lowest $J^\pi = 1^-$, T = 2 states in ^{14}N. (auth)

5992 MEASUREMENT OF THE NEUTRON POLARIZATION FOR THE $^{12}C(^{3}He,n)^{14}O$ REACTION BETWEEN 4.1 AND 5.9 MeV. Soltesz, C. R.; DeMartini, D. C.; Donoghue, T. R. (Ohio State Univ., Columbus). Phys. Rev., C; 4: No. 4, 1015-23(Oct 1971).

Angular distributions of the neutron polarization for the $^{12}C(^{3}He,n)^{14}O$ reaction have been measured at eight bombarding energies between 4.1 and 5.9 MeV. Large polarizations, both positive and negative valued, are observed over the whole energy range, with maximum values of +0.70 ± 0.06 at 5.7 MeV (90°) and −0.82 ± 0.04 at 4.5 MeV (75°). As $E(^{3}He)$ increases, the shapes of the polarization angular distributions shift continuously and and smoothly toward forward angles. A similar energy dependence is noted by Marr et al. for the proton-polarization measurements for the analog reaction $^{12}C(^{3}He, p_1)^{14}N^*$ (2.31-MeV state). The data for these two reactions bear much resemblance despite the difference of the Q values and possible Coulomb distortions in the proton exit channel. Although energy dependence in polarization angular distributions is not considered a usual characteristic of a direct-reaction mechanism, the smooth and continuous nature of the variation does suggest that this mechanism may be of some importance here. Exploratory two-nucleon-transfer distorted-wave calculations show that this theory can predict an energy dependence of the polarization using reasonable optical-model parameters for this energy and mass range. However, the trend of the calculations is contrary to the data, and little agreement with the data is found. (auth)

5993 ENERGY OF THE FIRST TWO EXCITED STATES OF ^{12}C. Stocker, H.; Rollefson, A. A.; Browne, C. P. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 4: No. 4, 1028-32(Oct 1971).

Owing to its importance in stellar helium burning, the excitation energy of the second excited state of ^{12}C was carefully remeasured with a tandem accelerator and a broad-range magnetic spectrograph. The excitation energy of this state is found to be 7655.9 ± 2.5 keV, in excellent agreement with two other recent measurements. This value lowers the calculated rate of the helium-burning process in stars by a factor of ≈3 from that previously assumed. A simultaneous measurement of the first excited state of ^{12}C gives 4442.2 ± 1.5 keV. A comparison is made with recent γ-ray measurements of this state. (auth)

5994 CALCULATION OF THE SEPARATION-ENERGY SPECTRUM IN THE REACTION $^{12}C(p,2p)$. Wille, U.; Gross, D. H. E.; Lipperheide, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin. Freie Univ., Berlin). Phys. Rev., C; 4: No. 4, 1070-3(Oct 1971).

The cross section for the $^{12}C(p,2p)$ reaction at an incident kinetic energy of 460 MeV is calculated in the framework of a model which takes account of nucleon-nucleon correlations and of the coupling to continuum channels of the residual nucleus. (auth)

5995 NUCLEAR-STRUCTURE CALCULATIONS IN ^{18}F. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay); Khadkikar, S. B. Phys. Rev., C; 4: No. 4, 1073-6(Oct 1971).

The two intrinsic Hartree-Fock (HF) states, one characterized by isospin $T = T_z = \frac{1}{2}(N - Z)$ and the other containing an admixture of $T = T_z$ and $T = T_z + 1$, lie energetically very close in the case of light odd-Z-odd-N nuclei. As a result, the low-lying $T = T_z$ states of these nuclei have substantial "band mixing." The HF projection formalism is employed to investigate the effect of band mixing on the properties of nuclear states in ^{18}F by explicitly treating all the nucleons. The results of the calculations are in fair agreement with the experimental data. (auth)

5996 OUTGOING ALPHA-CHANNEL RESONANCES IN REACTIONS HAVING ^{17}F AS AN INTERMEDIATE SYSTEM. Guazzoni, P. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan); Micheletti, S.; Pignanelli, M.; Gentilin, F.; Pellegrini, F. Phys. Rev., C; 4: No. 4, 1086-92(Oct 1971).

Excitation functions for the reactions $^{14}N(^3He,\alpha)^{13}N$ and $^{14}N(^3He,p)^{16}O$ have been measured in the energy range 3.75 to 10.75 MeV and 5.5 to 10.5 MeV, respectively. These data have been compared with those for the $^{16}O(p,p')^{16}O$ and the $^{16}O(p,\alpha)^{13}N$ reactions which also proceed through the same ^{17}F intermediate system. The results of this comparison support the hypothesis of α-like cluster resonances in the outgoing reaction channel. (auth)

5997 ENERGY DEPENDENCE OF THE THREE-NUCLEON TRANSFER REACTIONS ON LIGHT NUCLEI. Guazzoni, P.; Iori, I.; Micheletti, S.; Molho, N.; (and others) (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Phys. Rev., C; 4: No. 4, 1092-1103(Oct 1971).

Excitation functions and angular distributions for (p,α) reactions on ^{12}C, ^{15}N, and ^{16}O have been measured from 19- to 45-MeV incident energy. The mean slope of the integrated cross sections for all the above reactions and for (p,α) reactions on ^9Be, ^{11}B, and ^{19}F is the same, when plotted as a function of the intermediate-system excitation energy, and is of the type $[(E_p)_{c.m.} + B_p]^{-3.75}$. For the ^{12}C and ^{16}O targets, the differential and integrated cross sections, which have been measured in energy steps of the order of some hundred keV, show a marked resonant structure with modulations having widths and spacings of the order of 1 MeV. Angular distributions, although presenting a well-developed diffraction pattern especially at forward angles, vary very rapidly with energy, particularly below 30 MeV. The analysis of excitation functions performed with a distorted-wave Born-approximation point triton pickup calculation gives ambiguous results. A statistical Hauser-Feshbach calculation gives too steep a slope which agrees with experimental data only when direct transitions are hindered. The analysis of the excitation functions, performed in the framework of the pre-equilibrium decay model, gives satisfactory results. This could indicate that α emission from light nuclei cannot be treated as a simple direct effect. (auth)

5998 ADDITIONAL ACCURATE EXCITATION ENERGIES OF ^{11}B. Browne, C. P.; Stocker, H. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 4: No. 4, 1481-2(Oct 1971).

Inelastic proton scattering was used to measure the excitation energies of states in ^{11}B up to 9.3 MeV. Values for states up to 6.5 MeV agree with previous work. New values are 7285.6 ± 1.5, 7978.0 ± 1.7, 8559.4 ± 1.9, 8920.2 ± 2.0, 9185.0 ± 2.0, and 9274.4 ± 2.0 keV. Tabulated values disagree by as much as 18 keV. The 7978.0 value is in exact agreement with a recent γ-ray measurement. (auth)

5999 SPIN-FLIP PROBABILITY FOR INELASTIC PROTON SCATTERING FROM CARBON AND SULFUR. Wilson, M. A. D.; Schecter, L. (Oregon State Univ., Corvallis). Phys. Rev., C; 4: No. 4, 1103-9(Oct 1971).

The spin-flip probability for scattering protons inelastically to produce the first excited 2^+ states in ^{12}C and ^{32}S has been measured at proton energies of 15.9 and 17.5 MeV using the deexcitation γ rays emitted perpendicular to the scattering plane. The carbon results agree with previous measurements in the same proton energy region. The measured inelastic spin-flip probability on sulfur is higher than that reported for any other nucleus, exceeding a peak value of 0.5. A collective distorted-wave Born-approximation analysis employing the full Thomas spin-orbit interaction was carried out. Poor fits are obtained for the spin-flip-probability data when the depth and range of the spin-orbit optical potential are determined from elastic polarization data. (auth)

6000 TOTAL-REACTION-CROSS-SECTION MEASUREMENTS FOR 30- TO 60-MeV PROTONS AND THE IMAGINARY OPTICAL POTENTIAL. Menet, J. J. H.; Gross, E. E.; Malanify, J. J.; Zucker, A. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 4: No. 4, 1114-29(Oct 1971).

Total reaction cross sections were measured for 30-, 40-, 49.5-, and 60.8-MeV protons incident on thin, separated isotopes covering the range from ^{12}C to ^{208}Pb. The results are consistent with previous data at 30 MeV, but disagree with earlier data at 60 MeV. A strong dependence of the reaction cross section on neutron excess for a series of Fe and Ni isotopes was found. Little, if any, such dependence is observed for the N = 28 isotones. The data are well represented by the relation $\sigma_R = \pi(r_0 A^{1/3} + \lambda)^2$ with $r_0 = 1.23 \pm 0.01$ F. When analyzed with the conventional optical model, the data require the volume absorption to increase and the surface absorption to decrease with increasing proton energy E_p. The analysis reveals a striking $(N-Z)/A$ dependence for the product $W_D a'$. Using the Oak Ridge parameters for the real and spin-orbit potentials, the following parametrization for the imaginary potential was obtained: volume absorption potential, $W_0 = (1.2 + 0.09\ E_p)$ MeV; surface absorption potential, $W_D = [4.2 - 0.05\ E_p + 15.5\ (N-Z)/A]$ MeV; imaginary diffusivity, $a' = [0.74 - 0.008\ E_p + 1.0 \times (N-Z)/A]$ F. (auth)

6001 ALPHA–GAMMA ANGULAR CORRELATIONS IN ^{12}C, ^{24}Mg, ^{58}Ni, AND ^{120}Sn. Baron, N.; Leonard, R. F.; Stewart, W. M. (Lewis Research Center, Cleveland). Phys. Rev., C; 4: No. 4, 1159-73(Oct 1971).

The angular correlation between inelastically scattered α particles and the subsequent deexcitation γ ray has been measured at an α energy of 42 MeV. Measurements have been carried out in the reaction plane for γ rays resulting from the decay of the first excited (2^+) state of ^{12}C, ^{24}Mg, ^{58}Ni, and ^{120}Sn. The results are reported in terms of the γ-ray symmetry angle, θ_0, and the ratio A/B. Qualitatively the behavior of the symmetry angle is found to be the same for all four isotopes, rotating continuously at forward α-scattering angles and oscillating about the plane-wave and adiabatic predictions at larger α-scattering angles. For the three isotopes for which A/B measurements were possible, the ratio was clearly not identically zero. Both the angular-correlation and cross-section data are compared with the results of distorted-wave–Born-approximation calculations using a wide range of optical-model parameters. The optical-model ambiguities encountered here are similar to those found in fitting cross-section data alone. (auth)

6002 HIGH MOMENTUM PION PRODUCTION. Allardyce, B. W. (Rutherford High Energy Lab., Chilton, Eng.). pp 429-33 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Measurements are reported on high momentum pion production on ^{12}C, ^{13}C, and ^{14}N by protons and also on π^+/π^- production ratios in ^{12}C and ^{208}Pb. Attempts to fit the data by theoretical models were unsuccessful. (L.B.S.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 4611, 5034, 5171, 5717, 5899, 5950, 5960, 5961, 5964, 5966, 5969, 5970, 5972, 5976, 5989, 5999, 6000, 6001, 6055, 6058, 6069, 6074, 6075, 6078, 6103–6105, 6129, 6130, and 6146.

6003 (ANL–7837, pp 187-94) ELASTIC SCATTERING OF ^{28}Si BY ^{28}Si. Ferguson, A. J.; Haeusser, O.; McDonald, A. B.; Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1971.

From Symposium on heavy-ion scattering: Argonne, Ill. (25 Mar 1971).

Excitation functions for elastic scattering of ^{28}Si by ^{28}Si were measured at seven angles between 48.0 and 90.0° (cms) over the energy range 25 to 48.7 MeV (cms). In addition, differential cross sections are given at energies from 20 to 42 MeV. The results are analyzed with the Blair model. (R.W.R.)

6004 (ANL–7837, pp 309-16) ELASTIC SCATTERING OF ^{16}O FROM EVEN Ca ISOTOPES NEAR THE COULOMB BARRIER. Watson, B. A.; Tabor, S. L.; Bertin, M. C. (Stanford Univ., Calif. Dept. of Physics); Goldring, G.; Eisen, Y. (Weizmann Inst. of Science, Rehovoth (Israel)). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The elastic scattering of ^{16}O by $^{40,44,48}Ca$ at 20 to 42 MeV was used to study the relative sizes of these nuclei. The usual optical model was used to analyze the excitation functions obtained. The Rutherford radius of these Ca isotopes was found to vary approximately as A^{1}_{3}. This behavior suggests a neutron envelope outside the ^{40}Ca core that expands with mass number; this agrees qualitatively with shell model concepts. (R.W.R.)

6005 (FRNC-TH-106) ELECTROMAGNETIC TRANSITION PROBABILITIES IN ^{28}Si, ^{32}S, AND ^{36}Ar NUCLEI. Thibaud, Jean-Pierre (Bordeaux Univ. (France). Faculte des Sciences). 1970. 90p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The mean lives of various excited levels of the ^{28}Si, ^{32}S and ^{36}Ar nuclei were measured using Doppler shift attenuation. These levels were populated by proton radiative capture, and a good experimental accuracy was obtained. The results were compared with different predictions made from Hartree–Fock calculations. The axially symmetric deformation of the ^{28}Si nucleus was confirmed; the wave functions of the rotational model give a good description of the transition probabilities in the ground state rotational band. It seems probable that ^{32}S has a nonspherical equilibrium shape; thus spin-orbit interaction effects do not destroy completely the α-type correlations responsible for the deformations. ^{36}Ar was found to have a quasi-spherical equilibrium shape. (France)

6006 (LBL-224) DECAY OF T = 2 STATES IN $T_z = 0$ NUCLEI. Goth, George William (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 115p. Dep. NTIS.

Thesis.

The particle decays of the lowest T = 2 states of ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, ^{40}Ca and ^{56}Ni were measured. The states were populated through the (p,t) reaction on T = 1 targets and their isospin forbidden particle decays were measured by observing coincidences between tritons and protons ($E_p(max) = 2.6 - 3.7$ MeV) and/or alpha-particles ($E_\alpha(max) = 1.8 - 12.0$ MeV). These experiments established that particle decay accounts for almost all of the total widths of the states ($\Gamma_{particle}/\Gamma = 0.99 \pm 0.11$). The major decay modes of the states were found to be: $^{20}Ne(\alpha_1 + \alpha_2, \alpha_3 + \alpha_4)$; $^{24}Mg(p_0)$; $^{28}Si(\alpha_0)$; $^{32}S(p_0)$; $^{40}Ca(\alpha_0)$; $^{56}Ni(p_0)$. Comparison of these experiments with results from resonance reaction studies shows qualitative agreement. Simple Coulomb calculations were performed for the decay of the T = 2 state in ^{40}Ca; these assumed pure shell model configurations and considered isospin mixing in only the (1d,1f) shells. They failed to predict the relatively large T = 2 isospin admixtures necessary to explain the observed alpha-decay of this state. (auth)

6007 (NCSAC-38) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE. Meeting at Duke University, Durham, North Carolina on May 4–5, 1971. Chrien, R. E. (comp.) (Brookhaven National Lab., Upton, N. Y.). 238p. (BNL-50298; EANDC(US)-156(U); INDC(USA)-30(U); CONF-710526). Dep. NTIS.

ALUMINUM-28 — energy levels from aluminum-27 neutron capture, (E)
ARGON — neutron total cross section up to 1 MeV, (E)
BERYLLIUM-9 — neutron total cross section at 0.5 to 20 MeV, (E)
CALCIUM-48 — proton reactions (p,n) at 1.95 to 1.99 MeV, angular distributions for, (E)
CALIFORNIUM-252 — neutron fission at 0.01 to 5 MeV, cross section for, (E)
CURIUM-243 — neutron total cross section and resonance parameters at epithermal energies, (E)
CURIUM-244 — neutron total cross section and resonance parameters at epithermal energies, (E)
CURIUM-245 — neutron total cross section and resonance parameters at epithermal energies, (E)
CURIUM-246 — neutron total cross section and resonance parameters at epithermal energies, (E)
ERBIUM-167 — neutron capture up to 140 eV, low-energy γ-ray intensities from, (E/T)
FLUORINE-20 — energy levels from fluorine-19 neutron capture, (E)
GOLD-197 — neutron capture at 10 to 5400 keV, best-fit cross sections for, (E)
INDIUM-113 — neutron resonance parameters for, (E)
INDIUM-115 — neutron resonance parameters for, (E)
LATHANUM-139 — neutron resonance parameters for, (E)
LEAD-208 — neutron capture at 6 to 15 MeV, γ spectra and cross sections for, (E)
MAGNESIUM-25 — photon reactions (γ,n), (γ,np) and (γ,2n) up to 30 MeV, total cross sections for, (E)
MOLYBDENUM-92 — neutron capture by, analysis for valance neutron transitions in, (E/T)
MOLYBDENUM-98 — neutron capture by, analysis for valance neutron transitions in, (E/T)
NEODYMIUM-143 — neutron capture at resonance energies, resonance spin assignments for, (E)
NEODYMIUM-145 — neutron capture at resonance energies, resonance spin assignments for, (E)
NEPTUNIUM-237 — neutron capture at 0.487 eV, γ spectra from, (E)
RHENIUM-185 — neutron capture at resonance energies, time-of-flight spectra from, (E)
RHENIUM-187 — neutron capture at resonance energies, time-of-flight spectra from, (E)
RHODIUM-103 — neutron capture up to 1 keV, resonance parameters for, (E)
SAMARIUM-152 — neutron resonance parameters for, (E)
SAMARIUM-154 — neutron resonance parameters for, (E)
SILICON — neutron total cross section at 0.5 to 20 MeV, (E)
SODIUM-23 — photon reactions (γ,n), (γ,np) and (γ,2n) up to 30 MeV, total cross sections for, (E)
TANTALUM — neutron transmission and self-indication measurements below 100 keV, (E)
THORIUM-232 — neutron total cross section up to 4.2 keV, (E)
TUNGSTEN-183 — neutron capture by, γ spectra from thermal, (E)
— neutron capture at 2 keV, γ spectra from, (E)
URANIUM-233 — neutron fission up to 40 keV, cross section for, (E)
URANIUM-235 — neutron fission up to 40 keV, cross section for, (E)
— neutron capture at resonance energies, γ spectra from, (E)
— neutron fission at 12.5 to 350 keV, cross section for, (E)
URANIUM-238 — neutron total cross section and resonance parameters up to 3.6 keV, (E)
— neutron capture by, γ spectra from thermal and resonance, (E)
URANIUM-239 — energy levels from uranium-238 neutron capture, spin-parity assignments for, (E)
XENON-125 — energy-level scheme for, (E)
YTTERBIUM-170 — neutron capture at resonance energies, γ energies and intensities from, (E)
YTTERBIUM-171 — neutron capture at resonance energies, γ spectra and resonance spin assignments for, (E)
YTTERBIUM-172 — neutron capture at resonance energies, γ energies and intensities from, (E)
YTTERBIUM-173 — neutron capture at resonance energies, γ spectra and resonance spin assignments for, (E)
YTTERBIUM-88 — energy levels and transitions from ytterbium-89 (n,2n) reactions, (E) (J.W.R.)

6008 SPHERICAL STATES IN ^{44}Sc. McGrory, J. B.; Halbert, E. C. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 37B: No. 1, 9-12(1 Nov 1971).

Conventional shell-model calculations of energy levels in ^{44}Sc and of strengths for proton stripping and neutron pickup to states in ^{44}Sc are reported. The results are in excellent agreement with a set of states observed below 1.5 MeV in ^{44}Sc. There are at least 18 states below this energy that are not accounted for by the shell-model results. (auth)

6009 ^{48}Cr SPECTROSCOPY FROM THE $^{50}Cr(p,t)^{48}Cr$ REACTION. Bruandet, J. F.; Longequeue, N.; Longequeue, J. P.; Vignon, B. (Institut des Sciences Nucleaires, Grenoble, France). Phys. Lett.; 37B: No. 1, 58-60(1 Nov 1971). (In French).

Eighteen levels in the nucleus ^{48}Cr were observed in the reaction $^{50}Cr(p,t)^{48}Cr$; in particular, the first T = 1 state (at 5.88 ± 0.03 MeV) and the first T = 2 state (at 8.86 ± 0.03 MeV) were identified. DWBA calculations were performed and spin assignment, deduced for most of the excited states. (auth)

6010 COMBINED MICROSCOPIC AND PHENOMENOLOGICAL APPROACH TO THE REAL PART OF THE OPTICAL POTENTIAL FOR HEAVY ION REACTIONS. Eisen, Y. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 37B: No. 1, 33-6(1 Nov 1971).

The microscopic model together with a phenomenological analysis are applied to elastic scattering of $^{16}O + {}^{48,44,42,40}Ca$ at incident energies near the Coulomb barrier in order to extract nuclear matter differences in the outer region of these nuclei. (auth)

6011 INVESTIGATION OF THE (γ,np) REACTION IN ^{40}Ca AND ^{32}S. Bramanis, E. (Univ. of Melbourne, Parkville, Australia). Nucl. Phys.; A175: No. 1, 17-30(1971).

An experimental determination of the $^{32}S(\gamma,np)$ and the $^{40}Ca(\gamma,np)$ cross sections has been obtained from thresholds to 30 MeV by

counting residual γ-ray activity. These, and other results at higher energies were then compared with a theoretical estimate of the $^{40}Ca(\gamma,np)$ cross section made from calculations based on the quasi-deuteron theory. The effect of the residual nucleus on the final-state wave functions of the two emitted nucleons is important. By modifying these wave functions to include this interaction it was found that good agreement was obtained with experiment. (auth)

6012 (τ,p) REACTIONS ON Cr. II. $^{54}Cr(\tau,p)^{56}Mn$. Caldwell, T. (Univ. of Pennsylvania, Philadelphia); Pullen, D. J.; Mulligan, T. J.; Hansen, Ole. Nucl. Phys.; A175: No. 1, 31-44 (1971).

The $^{54}Cr(^3He,p)^{56}Mn$ reaction has been studied at 15 MeV incident energy using a multiangle spectrograph. Ninety-seven transitions were identified up to 5.62 MeV excitation and many of the corresponding proton angular distributions were measured. The systematics of L = 0 angular distributions shapes are discussed in detail and criteria for distinguishing L = 0 and L = 0 + 2 transitions are derived. The implication of the present data for the nuclear structure of ^{56}Mn is commented upon and the distribution of 1^+ $(^3He,p)$ strength in ^{56}Mn is discussed. (auth)

6013 BETA DECAY OF ^{26}Si, ^{30}S, AND ^{34}Ar. Moss, C. E.; Detraz, C.; Zaidins, C. S. (Univ. of Colorado, Boulder). Nucl. Phys.; A174: No. 2, 408-16(1971).

New branches in the β^+ decay of ^{26}Si, ^{30}S, and ^{34}Ar have been observed and their log ft values determined. Upper limits for the branching ratios are reported for unobserved branches. Values of $T_{\frac{1}{2}} = 1.22 \pm 0.03$ s for ^{30}S and $T_{\frac{1}{2}} = 0.74 \pm 0.11$ s for ^{34}Ar were obtained from an analysis of the decay of β-delayed γ-rays. Comparison of the pure Gamow-Teller β^+ transitions with the analogous M1 γ-transitions indicates that the orbital contribution is not negligible. (auth)

6014 ELECTROMAGNETIC PROPERTIES OF ^{51}Cr EXCITED STATES. Iyengar, K. V. K.; Robertson, B. C. (Univ. of Alberta, Edmonton). Nucl. Phys.; A174: No. 2, 385-98(1971).

The lifetimes of several levels in ^{51}Cr in the excitation range 1165–2767 keV were measured via the $^{51}V(p,n\gamma)^{51}Cr$ reaction using the Doppler-shift attenuation method. A value of $J^\pi = \frac{9}{2}^-$ is assigned to the level at 2766.4 keV, from angular distribution measurement of its γ-decay mode and from the lifetime determination. (auth)

6015 LIFETIMES OF EXCITED LEVELS AND ELECTROMAGNETIC TRANSITION RATES IN ^{147}Pm AND ^{199}Hg. Singh, H.; Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A174: No. 2, 437-48(1971).

The lifetimes of 687.4, 531.9, and 91.03 keV levels in ^{147}Pm and the 158.2 keV level in ^{199}Hg are measured by the delayed coincidence technique using a time-to-amplitude converter. The results are $T_{\frac{1}{2}}$(687.4 keV level, ^{147}Pm) = 0.25 ± 0.10 ns, $T_{\frac{1}{2}}$(531.9 keV level, ^{147}Pm) = 0.133 ± 0.030 ns, $T_{\frac{1}{2}}$(91.03 keV level, ^{147}Pm) = 2.57 ± 0.02 ns), $T_{\frac{1}{2}}$(158.2 keV level, ^{199}Hg) = 2.49 ± 0.03 ns. The energies and relative intensities of γ-rays in the decays of ^{147}Nd and ^{199}Au are determined using high-resolution Ge(Li) detectors. The γ-ray transition probabilities for M1 and E2 multipolarities are deduced from the above results. (auth)

6016 DECAY OF ^{68m}Cu(3.75 min) AND ^{68g}Cu(30 sec). Singh, H.; Tikku, V. K.; Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A174: No. 2, 426-36(1971).

The existence of the isomer of ^{68}Cu is confirmed and its half-life measured as 3.75 ± 0.05 min. The $^{68m,g}Cu$ activities have been produced by irradiation of enriched targets of ^{68}Zn (99.3%) and ^{71}Ga (98.1%), as well as spectroscopically pure ZnO targets, with 14 MeV neutrons. The 3.75 min ^{68m}Cu is found to decay to the 30 sec ground state of ^{68}Cu with the emission of γ-rays whose energies (keV) and relative intensities (given in parentheses) are: 84.6 ± 0.4 (95 ± 5), 110.4 ± 0.7(24.5 ± 1.7), 525.7 ± 0.4(100) and 635.9 ± 0.7(16.5 ± 1.5). The decay of the 30 sec ^{68}Cu was re-examined. A 4.60 MeV β-group (37%) corresponding to the transition from the ground state of ^{68}Cu to the ground state of ^{68}Zn is observed. The energies (keV) and relative intensities of the ^{68}Zn γ-rays observed in these studies are 577.6 ± 1.0(2.9 ± 0.5), 805.7 ± 1.0(3.0 ± 0.6), 1077.7 ± 0.5(82.4 ± 3.0), 1261.8 ± 0.8(17.5 ± 1.5), 1744.9 ± 1.5(2.7 ± 0.5), 1883.7 ± 1.5(1.8 ± 0.5) and 2339.5 ± 1.5 (1.1 ± 0.7). β-γ and γ-γ coincidence experiments were performed. A decay scheme is proposed for ^{68m}Cu with energy levels in ^{68}Cu at 84.6, 610.3 and 720.7 keV. The cross sections for the production of the metastable and ground states of ^{68}Cu by the reaction $^{68}Zn(n,p)^{68m,g}Cu$ at 14 MeV neutron energy have been measured and found to be 4.5 ± 0.8 and 6.5 ± 1.3 mb, respectively. (auth)

6017 INVESTIGATION OF COMPOUND ELASTIC SCATTERING NEAR ISOBARIC ANALOG RESONANCES WITH POLARIZED PROTONS. Kretschmer, W.; Graw, G. (Univ., Erlangen, Ger.). Phys. Rev. Lett.; 27: No. 19, 1294-6(8 Nov 1971).

A rather model-independent separation of direct and compound-elastic cross sections is obtained from the analysis of elastic scattering of polarized protons near the lowest $d_{\frac{3}{2}}$ isobaric analog resonances in ^{89}Y and ^{91}Nb. (auth)

6018 FINE STRUCTURE OF ANALOGUE STATES IN ^{51}Mn, ^{53}Mn, AND ^{55}Mn. Moses, J. D. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Newson, H. W.; Bilpuch, E. G.; Mitchell, G. E. Nucl. Phys.; A175: No. 3, 556-82(1971).

Excitation functions were measured for proton elastic scattering from $^{50,52,54}Cr$, inelastic scattering from ^{50}Cr, and the (p,n) reaction with ^{54}Cr. By using the TUNL 3 MV Van de Graaff accelerator and high-resolution analyzer–homogenizer system, a total resolution of 300 to 400 eV was achieved for thin solid targets of enriched chromium isotopes. Eleven analog states were observed; six of these showed well-developed fine-structure patterns. Spins, parities, and partial widths were determined for approximately 330 resonances. Spectroscopic factors and Coulomb energy differences were extracted for the eleven analog states. (auth)

6019 RULES FOR THE GROUND STATE SPINS OF DOUBLY ODD NUCLEI HAVING THE LAST NEUTRON AND PROTON FILLING THE SAME SUBSHELL. Gupta, S. K. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Phys.; A175: No. 3, 606-8(1971).

Two new empirical rules were found for the ground-state spins of doubly odd nuclei where the valence nucleons are filling the same subshell. The first rule is obeyed by all the nuclei except ^{34}Cl and the $f_{\frac{7}{2}}$ subshell nuclei. The second rule is applicable to the nuclei excluded by the first rule. The rules are identical for the nuclei having $T_z = 1$. (auth)

6020 GIANT DIPOLE STATES IN THE A = 90 MASS REGION. Lepretre, A. (CEN, Saclay, France); Beil, H.; Bergere, R.; (and others). Nucl. Phys.; A175: No. 3, 609-28(1971).

By using a monochromatic photon beam, giant dipole states in Rb, Sr, ^{89}Y, ^{90}Zr, and ^{93}Nb were investigated by means of (γ,n) + (γ,np) and (γ,2n) reactions. Structure observed in the threshold region is tentatively assigned to 1p–1h states, whereas structure observed around the mean giant resonance energy and in the higher energy region is ascribed to interference with isobaric analog resonances and predicted isospin splitting of dipole states, respectively. A particular study of the decay of $T_>$ states in $^{89}Y(\gamma,n)^{88}Y_{g.s.}$, $^{89}Y(\gamma,n)^{88m}Y$, and $^{89}Y(\gamma,2n)^{87}Y$ reactions was also made. (auth)

6021 MASS SPECTROMETRIC DETECTION OF ^{82}Se-DOUBLE BETA DECAY. Kirsten, T. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mueller, H. W.; Norton, E. pp 501-5 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Preliminary results of a search for ^{82}Kr excess in selenium ores, due to ^{82}Se double beta decay, are reported. Six different mineral samples were analyzed by mass spectrometry. A ^{82}Kr excess was found in all six samples. A half-life of 1.37×10^{20} yr was obtained from the analysis of umangite. (J.W.R.)

6022 NUCLEAR STRUCTURE OF ^{22}Na: THE $^{23}Na(^3He,\alpha)$ REACTION. Garrett, J. D.; Fortune, H. T.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 4: No. 4, 1138-58 (Oct 1971).

The states of ^{22}Na below 7.5 MeV have been studied using the $^{23}Na(^3He,\alpha)^{22}Na$ reaction at a bombarding energy of 18 MeV. Angular distributions of the reaction products have been compared with distorted-wave Born-approximation predictions. The resulting spectroscopic factors are compared with those calculated using the rotational model and with experimental spectroscopic factors from the $^{23}Na(p,d)$ and $^{23}Na(d,t)$ reactions. The results suggest a $K^\pi = 1^-$, T = 0 rotational band (2.21 MeV, 1^-; 2.57 MeV, 2^-; and 3.52 MeV, 3^-) and a $K^\pi = 2^-$, T = 0 band [4.58 MeV, 2^- (0^-, 1^-, 3^-) and 5.44 MeV, $3^-(0^-, 1^-, 2^-)$] based on neutron pickup from the $\frac{1}{2}^-$[101] Nilsson orbit. A comparison of the l = 1 $^{23}Na(^3He,\alpha)$ transition to the 5.95-MeV level in ^{22}Na with the $^{22}Na(d,^3He)^{22}Ne$ results suggests that this state is the analog of the 5.14-MeV, 2^- state in ^{22}Ne and that these levels correspond to the $K^\pi = 2^-$, T = 1 band head based on nucleon pickup from the $\frac{1}{2}$[101] Nilsson orbit. The results of the present study and a previous $^{21}Ne(^3He,d)^{22}Na$ study are discussed in terms of Nilsson configurations and associated rotational bands. It is found that the rotational model provides a reasonably adequate explanation for the observed spectroscopic factors of the negative-parity states up to 7.5 MeV and for the positive-parity states based on the $(\frac{3}{2}^+[211])^2$ configuration

if a deformation of $\delta \approx 0.5$ is assumed. The simple rotational model, however, is unable to account for the observed single-nucleon-transfer spectroscopic factors for the other positive-parity configurations. (auth)

6023 LOW-LYING LEVELS IN ^{46}Sc. Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., C; 4: No. 4, 1211-15 (Oct 1971).

The low-lying levels in ^{46}Sc have been observed with (^{3}He,t) reactions on ^{46}Ca by use of the 22.5-MeV ^{3}He beam of the Argonne tandem Van de Graaff and the split-pole spectrograph. Of the 26 levels observed below 3-MeV excitation, 18 were tentatively fitted with distorted-wave curves. In a number of cases the choices of possible spins for the levels could be reduced by comparing the present results with previous experiments. (auth)

6024 LINEAR-POLARIZATION MEASUREMENTS ON THE GAMMA DECAY FROM THE DOUBLET AT 3.00 MeV IN ^{27}Al. Lumpkin, A. H. (Johns Hopkins Univ., Baltimore); Hardy, K. A.; Lee, Y. K.; Owen, G. E.; Shnidman, R. Phys. Rev., C; 4: No. 4, 1215-19(Oct 1971).

The linear polarization has been measured for the 2.21-, 2.73-, 2.98-, and 3.00-MeV transitions in ^{27}Al. The mixing ratios δ(E2/M1) for these transitions were determined to be $\delta(2.21) = -0.57 \pm 0.08$, $\delta(2.73) = 0.22 \pm 0.09$, and $\delta(2.98) = 0.05 \pm 0.03$. The 3.00-MeV transition was found to be consistent with a pure E2 transition. The results are compared with the predictions of the rotational-vibrational model of Röpke. (auth)

6025 STUDY OF THE ^{40}Ca(^{3}He,t)^{40}Sc REACTION AT 30.2 MeV. Loiseaux, J.-M. (CEN de Saclay, Gif-sur-Yvette, France); Bruge, G.; Kossanyi-Demay, P.; (and others). Phys. Rev., C; 4: No. 4, 1219-30(Oct 1971).

The ^{40}Ca(^{3}He,t)^{40}Sc reaction has been studied using solid-state telescopes and a magnetic spectrograph. Data are compared with the results of microscopic calculations using either pure shell-model or configuration-mixed wave functions. The cross-shell transition strengths to the observed negative-parity states in ^{40}Sc have the same order of magnitude as those measured previously for the (^{3}He,t) reaction on the N = 28 nuclei. Empirical values have been obtained for the effective projectile-nucleon interaction. Using these values, some of the $[(f_{\frac{7}{2}})_p\,(d_{\frac{3}{2}}^{-1})_n]$, $[(p_{\frac{3}{2}})_p\,(d_{\frac{3}{2}}^{-1})_n]$, and $[(f_{\frac{7}{2}})_p\,(s_{\frac{1}{2}}^{-1})_n]$ states are identified and the effect of configuration mixing is discussed. (auth)

6026 SPECTROSCOPY OF THE EVEN Zn ISOTOPES BY INELASTIC ALPHA SCATTERING. Alpert, N. (Northeastern Univ., Boston); Alster, Jonas; Martens, E. J.; Pickles, William. Phys. Rev., C; 4: No. 4, 1230-9(Oct 1971).

The (α,α') reaction, at E_α = 31 MeV, on ^{68}Zn and ^{70}Zn was studied with an over-all energy resolution of 70–120 keV. Angular distributions are presented. New 3^-, 4^+, and 5^- assignments are made on the basis of distorted-wave Born-approximation (DWBA) calculations. Good angular distributions were obtained for double-excitation 2^+ states at 1.88 MeV in ^{68}Zn and at 1.78 MeV in ^{70}Zn. Fractionation of the octupole strength has been observed. Systematics of excitation energies and strengths are discussed for ^{64}Zn, ^{66}Zn, ^{68}Zn, and ^{70}Zn. (auth)

6027 STRUCTURE OF THE RANDOM-PHASE-APPROXIMATION GROUND-STATE WAVE FUNCTIONS OF ^{56}Ni AND ^{48}Ca. Gmitrova, E. (International Center for Theoretical Physics, Trieste, Italy); Gmitro, M.; Gambhir, Y. K. Phys. Rev., C; 4: No. 4, 1239-49(Oct 1971).

Conventional random-phase-approximation (RPA) and corrected RPA (MRPA) calculations are carried out for ^{56}Ni and ^{48}Ca nuclei, using the Tabakin potential without and with second-order Born corrections. The obtained ground-state wave functions are analyzed. The probability for the doubly-closed-shell (zero-particle, zero-hole) configurations is found to be small for ^{56}Ni [18% (RPA), 38% (MRPA)]. Similar numbers for the ^{48}Ca nucleus are, 35% RPA, 56% (80% for protons and 69% for neutrons) MRPA. In the case of ^{56}Ni, the T = 0 part contributes ≈95% to the shell breaking. The occupation numbers for single-particle and single-hole states are small except for the $1f_{\frac{7}{2}}$ hole and $1f_{\frac{5}{2}}$ particle states in ^{56}Ni, and for the $1d_{\frac{3}{2}}$ proton-hole state in ^{48}Ca. It is found that the conventional RPA using antisymmetrized matrix elements overestimates the calculated quantities of the ground state, roughly by a factor of 2. The effect of truncating the configuration space is also studied quantitatively. The results are compared with earlier investigations. (auth)

6028 HIGH-ENERGY PROTON SPALLATION OF TITANIUM. Brodzinski, R. L.; Rancitelli, L. A.; Cooper, J. A.; Wogman, N. A. (Battelle-Northwest, Richland, Wash.). Phys. Rev., C; 4: No. 4, 1250-7(Oct 1971).

The cross sections for the production of ^{49}V, ^{48}Sc, ^{47}Sc, ^{47}Ca, ^{46}Sc, ^{44m}Sc, ^{44}Ti, ^{43}K, ^{42}K, ^{28}Mg, ^{24}Na, ^{22}Na, and ^{7}Be from 15- to 584-MeV proton spallation of titanium are reported. The experimental production rates of the various isotopes and their ratios to ^{47}Sc are compared with theoretical spallation-yield calculations. Application of the measured excitation functions to the analysis of lunar materials and meteorites is discussed. (auth)

6029 HIGH-ENERGY PROTON SPALLATION OF IRON. Brodzinski, R. L.; Rancitelli, L. A.; Cooper, J. A.; Wogman, N. A. (Battelle-Northwest, Richland, Wash.). Phys. Rev., C; 4: No. 4, 1257-65(Oct 1971).

The cross sections for the production of ^{57}Co, ^{56}Co, ^{55}Co, ^{54}Mn, ^{52}Mn, ^{51}Cr, ^{48}Cr, ^{48}V, ^{48}Sc, ^{47}Sc, ^{46}Sc, ^{44m}Sc, ^{44}Ti, ^{43}K, ^{42}K, ^{24}Na, and ^{22}Na from 14.1 to 585-MeV proton spallation of iron are reported. The experimental production rates of the various radioisotopes and their ratios to ^{54}Mn are compared to theoretical spallation-yield calculations. These data and previously published data are combined to develop the excitation functions for these isotopes from proton spallation of natural iron. Applications of these excitation functions to beam monitoring and to the studies of meteorites and lunar surface material are discussed. (auth)

6030 E1 AND M1 RADIATIVE STRENGTH IN ^{53}Cr, ^{57}Fe, AND ^{61}Ni FROM THRESHOLD PHOTONEUTRON CROSS SECTIONS. Jackson, H. E.; Strait, E. N. (Argonne National Lab., Ill.). Phys. Rev., C; 4: No. 4, 1314-28(Oct 1971).

The photoneutron cross sections for ^{53}Cr, ^{57}Fe, and ^{61}Ni have been measured near threshold with high resolution. Nuclear states of interest were excited by photon absorption from a bremsstrahlung beam whose end-point energy was sufficient only for neutron decay to the ground state of the daughter. Spins of resonances were assigned on the basis of angular distributions determined from the spectra for neutron emission at angles of 90 and 135°; the ground-state radiation widths $\Gamma_{\gamma 0}$ for most resonances were determined from the observed yields. Parity assignments were based on a comparison of data with total neutron cross sections of the daughter nuclei. The central feature of the results in an intense p-wave component whose integrated strength for all targets is greater than that of the s-wave component. In addition, an anomalous concentration of M1 strength is observed in an intense doublet with $J^\pi = \frac{3}{2}^-$ at E_n = 230 keV in the cross section for ^{57}Fe. The reduced widths for E1 and M1 radiation are consistent with the values $k_{E1} = 0.0012$ and $k_{M1} = 0.019$, respectively. No evidence is found in the reactions ^{53}Cr(γ,n) and ^{57}Fe(γ,n) near threshold for doorway states which have been proposed in the literature. The data were also tested for a correlation between the reduced neutron width for s-wave resonances in each target and the corresponding ground-state radiation widths. In no case is there evidence for a significant correlation. Therefore the strong correlation reported between the reduced neutron widths and total radiation widths for s-wave resonances in even-even target nuclei in this mass region should not be attributed to the ground-state transition. (auth)

6031 DIFFERENTIAL ELASTIC CROSS SECTIONS FOR PROTONS BETWEEN 10 AND 22 MeV ON ^{40}Ca. Dicello, J. F. (Los Alamos Scientific Lab., N. Mex.); Igo, G.; Leland, W. T.; Perey, F. G. Phys. Rev., C; 4: No. 4, 1130-8(Oct 1971).

The differential elastic cross sections for protons on ^{40}Ca have been obtained at energies between 9.8 and 21.7 MeV. A mass-identification system using an E + ΔE detector was employed for the measurements. Relative uncertainties are approximately ±2%. Absolute uncertainties are approximately ±5%. An optical-model analysis of these data and the available polarization data in the same energy region have been performed. Reasonable fits were obtained by analyzing the data above and below 16.6 MeV separately. Significant differences in the imaginary and spin-orbit potentials were observed in these two regions. (auth)

6032 HALF-LIFE OF ^{53}Mn. Honda, Masatake; Imamura, Mineo (Tokyo Univ.). Phys. Rev., C; 4: No. 4, 1182-8(Oct 1971).

A value of 3.7×10^6 yr (±10%) for the half-life of ^{53}Mn was determined by a direct method involving measurement of both the specific activity [(dis/min ^{53}Mn)/(μg Mn)] and the isotope ratio (^{53}Mn/^{55}Mn). The ^{53}Mn specific activities were determined by neutron activation, and the ^{55}Mn/^{53}Mn isotopic ratios by mass spectrometry. A surface-ionization method was applied using a rhenium single filament with the sample mounted in a silica-gel layer. This technique gave a stable and enhanced ion beam of Mn^+. One source of ^{53}Mn was an electroplated Cr target bombarded by 15-MeV α particles in a cyclotron. The other source of ^{53}Mn was the Mn fractions extracted from iron meteorites by carrier-free processes. Activities of 10 dis/min ^{53}Mn and 2000 dis/min ^{54}Mn were obtained with about 2 μg of ^{55}Mn from the Cr target. The isotopic ratio ^{55}Mn/^{53}Mn was 750. Activities of about 1 (dis/min ^{53}Mn)/(μg Mn) and isotopic ratios ^{55}Mn/^{53}Mn of 3000–4000 were obtained from the iron-meteorite extracts. (auth)

6033 ANALYSIS OF THE SCATTERING OF 24-MeV ^{3}He PARTICLES FROM THE EVEN ISOTOPES OF ZINC. Hansen, Luisa F.; Kammerdiener, John L.; Weiss, Morton S. (Univ. of California, Livermore). Phys. Rev., C; 4: No. 4, 1189-1200 (Oct 1971).

The differential cross sections for elastic and inelastic ^{3}He scattering from ^{64}Zn, ^{66}Zn, ^{68}Zn, and ^{70}Zn targets have been measured at 24 MeV. The first 2^+ and the 3^- inelastic levels are strongly excited in comparison with the excitation of the second 2^+ and 0^+ levels. Assuming a priori a one-phonon-transfer process, the gound state and strongly excited 2^+ and 3^- angular distributions have been calculated using a coupled-channel code. The optical-model parameters used were obtained from analysis of the elastic scattering. Different optical potentials were used in the calculations. The quality of the fits to the inelastic levels, as well as the dependence of the magnitude of the deformation parameters on the geometrical parameter of a given optical potential, are discussed. The deformation lengths deduced from these measurements are in good agreement with those derived from similar analysis using other projectiles. (auth)

6034 GAMMA-RAY SPECTROSCOPY ON ^{28}Al. Boerma, D. O.; Smith, Ph. B. (Univ., Groningen, Netherlands). Phys. Rev., C; 4: No. 4, 1200-11(Oct 1971).

Properties of levels of ^{28}Al with $E_{ex} < 2.7$ MeV have been studied by means of the reactions ^{27}Al(d,pγ)^{28}Al, ^{26}Mg(^{3}He,pγ)^{28}Al, and ^{30}Si(d,$\alpha\gamma$)^{28}Al. The decay schemes of the first 12 excited states were determined. The known level at 1.62 MeV was found to consist of a doublet with a separation of 2.5 ± 1 keV. Particle-γ angular-correlation measurements using an annular silicon diode and a Ge(Li) detector led to spin-parity assignments of 3^+, (2^+) for the third level, and 1^+ for the fourth level. For a number of γ-ray transitions the E2/M1 mixing ratio was determined. A new method was applied to the measurement and analysis of the angular correlations. The results obtained are compared with the predictions of a simple shell model. (auth)

6035 α STRUCTURES FOR A = 4N NUCLEI IN THE 2s-1d SHELL. Hauge, Paul S. (Iowa State Univ., Ames); Williams, S. A.; Duffey, George H. Phys. Rev., C; 4: No. 4, 1044-61(Oct 1971).

The classical α-particle model has been consistently applied to all 4N nuclei in the 2s-1d shell. The ^{20}Ne nucleus was found to be a D_{2d} distorted tetrahedron in agreement with earlier investigations. Electron scattering form factors were predicted, but there are at present no experimental data for comparison. Most interesting results were obtained for ^{24}Mg, where the experimental matrix elements, energy spectrum, and electron scattering form factors were found to definitely favor a D_{2h} bitetrahedron over the D_{4h} square bipyramid used in other papers. Recent experiments on ^{28}Si also slightly favor an oblate D_{3d} structure over the previously considered D_{5h} pentagonal bipyramid. No definite structures could be established for ^{32}S and ^{36}Ar, because of the large number of α particles involved. However, a unique structure was found for ^{40}Ca. It consists of six α clusters arranged in an octahedron outside of a tetrahedral ^{16}O core. (auth)

6036 MEAN LIFETIME OF THE 1.368-MeV 2^+ LEVEL OF ^{24}Mg. Swann, C. P. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., C; 4: No. 4, 1489-90(Oct 1971).

A mean life of 1.92 ± 0.15 psec has been obtained for the 1.368-MeV 2^+ state of ^{24}Mg by comparing the resonant scattering of γ rays through the ^{24}Mg level and through the 1.333-MeV 2^+ state of ^{60}Ni, the lifetime of which is known accurately. This value is in good agreement with recent Coulomb-excitation results but differs markedly from a recent resonance-fluorescence self-absorption result. (auth)

6037 FURTHER COMPARISONS AND SHELL-MODEL ANALYSIS FOR NUCLEI WITH N = 28, 20 < Z ≤ 28. Lips, K. (Univ. of Kentucky, Lexington). Phys. Rev., C; 4: No. 4, 1482-5 (Oct 1971).

Comparisons are given between newly available experimental information about electromagnetic transitions in ^{52}Cr, ^{53}Mn, and ^{54}Fe and the theoretical predictions of a recently presented mixed-configuration shell-model calculation which permits small $2p_{\frac{3}{2}}$ and $1f_{\frac{5}{2}}$ admixtures in the $1f_{\frac{7}{2}}$-shell states. The agreement obtained between theoretical and measured values supports the conclusion that this model gives a good picture of E2 and M1 transition strengths as well as level spacings and proton spectroscopic factors in this region. (auth)

6038 EXPERIMENTAL EVIDENCE FOR QUARTET STRUCTURE IN Cr AND Ti ISOTOPES. Faraggi, H.; Lemaire, M.-C.; Loiseaux, J.-M.; Mermaz, M. C.; Papineau, A. (CEN, Saclay, France). Phys. Rev., C; 4: No. 4, 1375-81(Oct 1971).

The (^{16}O,^{12}C) α-transfer reaction has been studied on several Ca and Ti target isotopes using the 40- and 48-MeV ^{16}O beams of the Saclay FN tandem Van de Graaff. This work is the natural extension of the previous one performed on various Fe and Ni target isotopes. As previously observed for Ni and Zn residual nuclei, a small number of levels are strongly and selectively excited at low energy. This α-transfer reaction appears, then, as a new spectroscopic tool to study four-nucleon correlations. In close connection with the previous data on Fe and Ni targets, the present article points out the importance in residual nuclei of the quartet structure: namely two protons and two neutrons mutually strongly bound and weakly coupled to the target core. A strong blocking effect on the quartet is observed as soon as a neutron-pair excess is present in the target ground state. This neutron blocking effect has been already observed in the Fe and Ni target case. The existence in the 1f-2p shell of quarteting phenomena, i.e., the presence of four highly correlated nucleons giving rise to a quasirotational band, establishes the interplay between spherical and deformed states already known to exist in lighter nuclei. (auth)

6039 APPLICABILITY OF THE CONSTANT-NUCLEAR-TEMPERATURE APPROXIMATION IN STATISTICAL-MODEL CALCULATIONS OF NEUTRON CROSS SECTIONS AT 14.4 MeV FOR MEDIUM-Z NUCLEI. Lu, Wen-deh; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 4: No. 4, 1173-81(Oct 1971).

Cross sections of (n,2n), (n,p), and (n,α) reactions of medium-Z nuclei at 14.4 MeV, calculated from the statistical model with the constant-nuclear-temperature approximation for level densities, are compared with experiment. Using effective thresholds for second- and third-emitted neutrons, obtained by adding 0.5 and 1 MeV to the ground-state thresholds, respectively, the agreement with experiment is about ±15, ±20, and ±30% for (n,2n), (n,p), and (n,α) reactions, respectively. For (n,α) reactions, it is necessary to add 1 MeV to the pairing energy for the shell closures at N = 50 and 82 to get satisfactory agreement. An average nuclear temperature of 1.5 MeV is used for all types of reactions and for all nuclei investigated. The exponential dependence on (N−Z)/A for (n,p) cross sections in Levkovskii's empirical formula is derived from the statistical model and a semiempirical mass equation. Empirical equations are obtained which depend only on A and Z for quick estimation of 14.4-MeV (n,2n) cross sections from Z = 28 to 82 and of [(n,np) + (n,pn) + (n,d)] cross sections of the lightest stable isotope of even-Z elements in the region of Z = 28 to 50. (auth)

6040 STUDY OF ^{20}F USING THE ^{18}O(t,nγ) REACTION. Pronko, J. G.; Nightingale, R. W. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., C; 4: No. 4, 1023-7(Oct 1971).

Some of the low-lying excited states of ^{20}F were studied using the ^{18}O(t,nγ)^{20}F reaction at a bombarding energy of E_t = 2.7 MeV. The methods of n-γ and γ-γ angular correlations were used to obtain information concerning the spins of the 823- and 656-keV states and the multipole mixing ratios of the subsequent electromagnetic deexcitations of these states. The mean lifetime of the 823-keV state was measured with the recoil-distance technique to be 79 ± 6 psec. The results of the experiment are discussed in terms of current nuclear models. (auth)

6041 PHASE-EQUIVALENT AMBIGUITIES IN AN OPTICAL MODEL: COUPLED-CHANNEL ANALYSIS OF α + ^{24}Mg SCATTERING AT 17 MeV. Eberhard, K. A.; Robson, D. (Florida State Univ., Tallahassee). Phys. Rev., C; 3: 149-53(Jan 1971).

The existence of phase-equivalent ambiguities in the generalized optical model is investigated using a coupled-channel analysis of α + ^{24}Mg at 17 MeV. When compound-nucleus contributions are included in the analysis, it is found that the phase-equivalent ambiguities typical of the spherical optical potential still occur when the potential is nonspherical. The values obtained for the deformation parameter which are appropriate for the rotational states of ^{24}Mg are found to be relatively insensitive to the choice of a phase-equivalent potential. A simple explanation of this insensitivity has not yet been found. (auth)

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Refer also to abstracts 4180, 4567, 4907, 5034, 5159, 5717, 5899, 5950, 5964, 5976, 6000, 6001, 6007, 6017, 6020, 6039, 6109, 6130, 6136, and 6146.

6042 (AI-AEC-12990) AN EVALUATION OF ^{181}Ta AND ^{182}Ta FOR THE ENDF/B DATA FILE. Ottewitte, E. H.; Otter, J. M.; Rose, P. F.; Dunford, C. L. (Atomics International, Canoga Park, Calif.). 30 Sep 1971. Contract AT(04-3)-824. 58p. (ENDF-150). Dep. NTIS.

Neutron cross section data for ^{181}Ta and ^{182}Ta have been evalu-

ated at Atomics International for the ENDF/B library. Because of the lack of experimental data for ^{182}Ta, much of the information contained in the data set is based on theoretical calculations. A complete set of neutron cross section data was prepared for each nuclide for incident neutron energies between 10^{-5} ev and 17 MeV. These data, in ENDF/B format, are available from the National Neutron Cross Section Center at Brookhaven National Laboratory. (auth)

6043 (BNL–50283) NUCLEUS AS A SPINNING TOP. Cohen, Victor W. (Brookhaven National Lab., Upton, N. Y.). 18 Feb 1970. 12p. Dep. NTIS.

Brookhaven Lecture Series Number 90.

The use of atomic beams in studies of nuclear and atomic structure is reviewed. The basic principles of magnetic resonance are discussed. Techniques for the measurement of nuclear spins and magnetic moments are described. The hyperfine anomaly and detailed structure are also discussed. (J.W.R.)

6044 (FRNC-TH-80) STUDY OF THE CHARGE ON THE ^{208}Pb AND ^{208}Tl RECOIL ATOMS FORMED IN THE α DISINTEGRATION OF ^{212}Po AND ^{212}Bi. Meyer, Joseph (Strasbourg Univ. (France)). 1971. 66p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The charge possessed by the recoil atoms ^{208}Pb and ^{208}Tl formed in the α disintegration of ^{212}Po and ^{212}Bi supported by solid supports revealed the following facts: the charge distribution depends upon the mode of disintegration of the parent atom; when the α emission effects are not followed by an internal conversion, the charge on the recoil atoms is between –1 and +6; the emission probabilities of ^{208}Pb^{+} and ^{208}Pb^{0}, ^{208}Tl^{0} and ^{208}Tl^{+} are of the same order of magnitude, although the abundances of ^{208}Pb^{+n} and ^{208}Tl^{+n} decrease rapidly with increasing n. The mean charge on ^{208}Tl is <1; when ^{208}Tl is produced by the emission of an α particle followed by conversion, its charge lies between +5 and +20. The charge distribution of ^{208}Tl^{+n} resulting from the reorganization of the electron distribution subsequent to L or M ionization is not affected by the nature of the support. In contrast, the charge distribution of ^{208}Pb subsequent to pure α disintegration depends upon the support (mica, mylar, Al). (France)

6045 (FRNC-TH–114) LIFETIMES OF LEVELS OF ^{159}Tb, ^{165}Ho, AND ^{181}Ta MEASURED BY THE MICROWAVE METHOD. Gerber Jean (Strasbourg Univ. (France). Faculte des Sciences). 19 May 1970. 94p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Nuclei were excited by a 4-MeV alpha beam. The lifetimes of the first excited levels of ^{165}Ho and ^{181}Ta, and the second excited level of ^{159}Tb were measured. The transition probabilities obtained were discussed in terms of general models of deformed odd nuclei. The microwave method was shown to give direct information on the nuclear magnetic parameters. (France)

6046 (GULF-RT-A–10739) NEUTRON CROSS-SECTION RESEARCH. Final Report. Carlson, A. D.; Fricke, M. P. (Gulf Radiation Technology, San Diego, Calif.). 21 Jun 1971. Contract AT(04-3)-167. 29p. Dep. NTIS.

This report discusses neutron cross-section research performed under Contract AT(04-3)-167, Project Agreement No. 11, with the USAEC Division of Research. Highlights of the program, from its inception in 1961 to the present final report, are briefly summarized. Discussed in greater detail is the past year's work on neutron resonance parameters and spin assignments for unbound levels in ^{103}Rh. The average resonance parameters for ^{103}Rh were investigated, and an infinite-dilution resonance integral was determined. Also reported are recent results of experimental and theoretical studies of average capture cross sections for several nuclei in the region extending to 1-MeV neutron energy. (auth)

6047 (JINR-P6-6002) DECAY ENERGY FOR ^{140}Nd → ^{140}Pr. Baier, G. Yu.; Buttsev, V. S.; Gromov, K. Ya.; Kalinnikov, V. G.; Mortensen, K. O.; Nil'ssen, G. L.; Tikhonov, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

The ratio of K-capture in the electron capture of ^{140}Nd was measured ($W_K/W_\epsilon = 0.745 \pm 0.048$), whence it follows that the decay energy of ^{140}Nd is $Q_\epsilon = 131^{+45}_{-28}$ keV. The beta transition between the ground states of ^{140}Nd and ^{140}Pr is characterized by the quantity log ft = $4.18^{+0.48}_{-0.30}$. (tr-auth)

6048 (JINR–P6-6054) INVESTIGATION OF THE EXCITED STATES IN NUCLEI ^{139}Pr. Krupa, E.; Morozov, V. A.; Muminov, T. M.; Razov, V. I.; Fuya, Kh.; Khalikulov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Angular $\gamma\gamma$-correlations for 114 to 708 and 114 to 738 keV cascades in ^{139}Pr nuclei were studied. The life-time of the 822 keV level of ^{139}Pr was measured ($T_{\frac{1}{2}}$ = (36.8 ± 2.0 nsec). The results of investigations allow the value of spin of the excited 852-keV state ($I^{\pi} = 11/2^{+}$) to be determined. (auth)

6049 (LA–4763) TABULATION OF THE FISSION CROSS SECTION OF ^{237}Np FROM PHYSICS 8. Jiacoletti, R. J.; Brown, W. K. (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 24p. Dep. NTIS.

A tabulation of the measured values of the neutron-induced fission cross section of ^{237}Np from 20 eV to 7 MeV is presented. An underground nuclear explosion in the summer of 1969 provided the neutron source. (auth)

6050 (LA-DC–12705) HIGH RESOLUTION NEUTRON CROSS SECTIONS. Moore, M. S. (Los Alamos Scientific Lab., N. Mex.). [1971]. 32p. (CONF-710814–2). Dep. NTIS.

From International conference on statistical properties of nuclei; Albany, N. Y. (22 Aug 1971).

Current techniques in the measurement and analysis of high resolution neutron cross sections are reviewed. In the energy region in which the resonance structure is resolved, only for fissile target nuclei is the present situation unsatisfactory. This is attributed to insufficient data, particularly with respect to resonance spins. Fission fragment anisotropies are found to be correlated both with fission widths of the resonances and with the fission mass distribution, and such measurements are expected to be fundamental to resonance analysis. In the unresolved resonance region, the fissionable targets still are a major problem because of intermediate structure in fission. While a systematic approach to the problem is still lacking, the use of a runs statistic (following a suggestion by G. D. James) seems to hold promise. (auth)

6051 (LBL-221) CALORIMETRIC DETERMINATION OF THE TRANSITION ENERGY OF ^{235m}U. Culler, Barbara Ellen Bailey (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 111p. Dep. NTIS.

Thesis.

The isomeric state of uranium-235 decays by internal conversion, emitting electrons of extremely low energy. Hence, the transition energy is difficult to measure by conventional means. A microcalorimeter was designed and constructed to measure directly the heat produced by the decay. The value obtained for the transition energy was 572 ± 33 eV. The half life for alpha decay of the isomer was calculated to be 5.9×10^{8} years. In addition the probability of Coulomb excitation of the isomeric state by interstellar protons was estimated and found to be negligible. These two results eliminate a possible uranium-235 removal mechanism in space, and substantiate the use of the ratio ^{235}U/^{238}U to determine the age of the galaxy. (auth)

6052 (NP–18993) PROGRESS REPORT, 1970. Kinell, Per Olof (ed.) (Forskningsradens Laboratorium, Studsvik (Sweden)). 62p. (LF-34). Dep. NTIS (U. S. Sales Only).

A summary is given of the current research projects at the Swedish Research Councils' Laboratory, in close proximity to the materials testing reactor R2 at the research establishment of AB Atomenergi, Studsvik, Nyköping. Physical, chemical, medical, biological and technical applications of high intensity neutron fluxes, short-lived radioactive isotopes and high-intensity radiation sources are reviewed. (FHS) (SW)

6053 (ORO–2791-27) ANNUAL PROGRESS REPORT [ON NEUTRON-INTERACTION GAMMA RAYS]. Tucker, W. E.; Ashe, J. B.; Buchanan, P. S.; Clausen, K. D.; Morgan, I. L.; Nellis, D. O.; Williams, G. H. (Texas Nuclear Corp., Austin). 15 Aug 1968. Contract AT(40-1)-2791. 163p. Dep. NTIS.

This report describes the work undertaken during the past year as part of the neutron cross section program sponsored by the Atomic Energy Commission. A brief description of the measurement technique and instrumentation is given, followed by a description of computer usage and theoretical programs in use. This is followed by a description of the gamma-ray production cross sections and angular distribution measurements made during the year. A table summarizing the present status of the overall cross section program at Texas Nuclear Corporation is included. (auth)

6054 (TID–25844) INVESTIGATIONS OF THE LEVEL STRUCTURE AND OF THE ROTATION-VIBRATION INTERACTION IN ^{156}Gd AND ^{158}Gd. Kluk, Anthony F. (Vanderbilt Univ., Nashville, Tenn.). Aug 1971. 195p. Dep. NTIS.

Thesis.

Accurate energies and intensities of γ-rays in the decay of 15 d ^{156}Eu and 46 min ^{158}Eu were measured through the use of large-volume, high resolution Ge(Li) detectors in both the singles and $\gamma-\gamma$ coincidence modes. Special emphasis was given to measuring

the intensities of the γ-rays which depopulate the β- and γ-vibrational bands of both nuclei. The 0^+ and 2^+ members of the γ-band in ^{156}Gd were observed. In ^{158}Gd, the 2^+ and 3^+ members of the γ-band were reported as well as weak evidence for the γ-rays which depopulate the 0^+ and 2^+ members of the β-band. The γ-ray branching ratios from the levels of the β- and γ-bands are interpreted in terms of the Bohr-Mottelson collective model with a first and second order perturbation treatment of the mixing between the β- and γ-bands and the ground state rotational band. For both nuclei, a first order perturbational treatment did not account for the branching ratios between the γ-vibrational and ground-state rotational bands. Mixing between the β- and γ-vibrational bands is considered from two approaches, but it is concluded that neither accounts satisfactorily for the branching ratios of both the β- and γ-vibrational bands of ^{156}Gd. Coincidence relations were used extensively to establish new level schemes which give a more detailed picture of the decay properties of both ^{156}Eu and ^{158}Eu. On the basis of half-life measurements, 95 transitions were observed in the decay of ^{156}Eu, 84 of which were assigned to a level scheme of 26 excited states in ^{156}Gd. From ^{158}Eu decay, 89 of 140 observed transitions and 29 excited levels were placed in the level scheme of ^{158}Gd. Possible spins and parities were determined for the excited states and a detailed discussion of the features of each assigned level is given for both nuclei. (auth)

6055 (UAE-NPL-1016) VACUUM RECOIL CORRECTION TO DOPPLER SHIFT ATTENUATION MEASUREMENTS. Robertson, B. C. (Alberta Univ., Edmonton, Nuclear Research Centre). Mar 1970. 10p. Dep. NTIS (U. S. Sales Only).

The correction to Doppler shift attenuation measurements due to vacuum recoils is calculated for the case that the target also serves as stopping material. The correction is shown to depend on the recoil range, the target thickness, and the nuclear lifetime. (auth) (Canada)

6056 MAGNETIC HYPERFINE SPLITTING OF THE $2s_{\frac{1}{2}}-2p_{\frac{1}{2}}$ TRANSITION IN MUONIC ^{115}In. Link. R.; Backe, N.; Engfer, R.; (and others) (CERN, Geneva). Phys. Lett.; 37B: No. 1, 50-2 (1 Nov 1971).

In ^{115}In a magnetic hf splitting of the muonic $2s_{\frac{1}{2}}-2p_{\frac{1}{2}}$ transition was observed. From this the hf constant $A_1(2s_{\frac{1}{2}}) = 280 \pm 60$ eV and an improved value $A_1(2p_{\frac{1}{2}}) = 520 \pm 60$ eV were deduced. The experimental results are compared to calculations on the basis of the shell model with configuration mixing. (auth)

6057 COUPLED CHANNEL ANALYSIS OF ASYMMETRY MEASUREMENTS FOR LOW-LYING STATES OF ^{148}Sm AND ^{152}Sm BY INELASTIC PROTON SCATTERING. Kurepin, A. B.; Lombard, R. M. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 37B: No. 1, 55-7(1 Nov 1971).

Asymmetries and differential cross sections were measured for elastic and inelastic scattering of 24.5-MeV polarized protons from the spherical nucleus ^{148}Sm. The comparison with the results of an asymmetry measurement at the same proton energy on the rotational nucleus ^{152}Sm shows significant differences for the first 2^+ states. A coupled-channels analysis for the first 2^+ and 3^- states in ^{148}Sm and for the 2^+ and 4^+ states of the ground-state rotational band in ^{152}Sm fits the experimental data very well. (auth)

6058 CONSTRUCTION OF COMPLEX DECAY SCHEMES WITH THE AID OF A COMPUTER. Rester, A. C. (Delft Univ. of Tech., Netherlands). Nucl. Instrum. Methods; 96: No. 2, 269-79(1971).

A computer program which searches for new energy levels in a nuclear decay is described. The program makes use of any of the following data when available: known level energies, spins and parities, alpha and beta feedings, transition energies and intensities, multipolarities, coincidence relations, and the Q-value of the decay. It is shown that energy sum rules alone are not sufficient evidence to establish the existence of levels in a complex decay. Criteria for judging the evidence for possible energy levels are proposed. (auth)

6059 DETERMINATION OF HALF LIVES WITH AN ON-LINE ISOTOPE SEPARATOR. Winsberg, L. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 96: No. 2, 301-7(1971).

Short-lived nuclides may decay appreciably during the time of transit T_t from the target to the collector in an on-line isotope separator. In order to get reliable half-life values, it is necessary in general to correct for the distribution $p(T_t)$ in the values of the transfer time. Several typical cases, both with $T_t = 0$ and with $T_t \neq 0$, will be considered. (auth)

6060 COMMENT ON THE MOMENTUM MISMATCH IN THE ^{144}Sm$(\tau,\alpha)^{143}$Sm REACTION. Woollam, P. B.; Griffiths, R. J. (King's Coll., London). Phys. Lett.; 37B: No. 1, 13-14(1 Nov 1971).

Spectroscopic factors extracted from a DWBA analysis of the reaction ^{144}Sm$(^3$He,$\alpha)^{143}$Sm at 18 MeV are compared with recent measurements of the corresponding (p,d) reaction and show a factor of six difference between the values obtained for the $l = 0$ transition at 0.107 MeV. (auth)

6061 PROTON RADIATIVE CAPTURE INTO ^{209}Bi THROUGH GIANT RESONANCES AND ANALOG RESONANCES. Snover, K. A.; Amann, J. F.; Hering, W.; Paul, P. (State Univ. of New York, Stony Brook). Phys. Lett.; 37B: No. 1, 29-32(1 Nov 1971).

Detailed ^{208}Pb(p,γ)^{209}Bi measurements show interfering giant dipole and isobaric analog resonances. A model analysis of the interference yields either inhibited or enhanced E1 radiative strengths for the analog resonances, depending on the intrinsic phase difference between the analog resonances and the giant dipole resonances. The inhibited E1 strengths are comparable to analogous β-decay strengths previously measured in this mass region. (auth)

6062 DECAY OF ^{162m}Ho TO LEVELS IN ^{162}Dy. Wood, J. L.; Brenner, D. S. (Clark Univ., Worcester, Mass.). Nucl. Phys.; A174: No. 2, 353-64(1971).

The γ-ray spectrum of the decay of ^{162m}Ho to levels in ^{162}Dy has been studied with Ge(Li) detectors. The results are in agreement with recent extensive studies of the level scheme of ^{162}Dy by a variety of experimental methods. In addition, evidence was found for population of levels at 1390.5, 1400.3 and 1453.6 keV which are assigned $I^\pi = 5^-$, 2^+ and 2^+, respectively. The log ft value suggests that the 1390 keV state has the two-quasiparticle configuration $\{p[411\uparrow]; p[523\uparrow]\}5^-$. The half-life of ^{162m}Ho has been measured to be 63.5 ± 1.9 min. (auth)

6063 ENERGY LEVELS OF ^{91}Nb FROM ^{91}Zr(p,nγ)^{91}Nb REACTION. Matsuki, S.; Yoshida, Y.; Hyakutake, M.; (and others) (Kyushu Univ., Fukuoka). Nucl. Phys.; A174: No. 2, 343-52 (1971).

The energy levels of ^{91}Nb were studied by means of the (p,nγ) reaction. The de-excitation γ-rays were observed with a high-resolution Ge(Li) detector in the proton energy range from 3.25 to 5.51 MeV in steps of about 30 keV. Many new low-lying states were populated by this reaction. Excitation energies up to 3.33 MeV were determined with high precision, and the decay scheme of ^{91}Nb is proposed. Resonances attributed to isobaric analog states in the compound system ^{92}Nb were observed in the excitation functions of the de-excitation γ-rays. (auth)

6064 DIRECT INTERACTION EFFECTS IN THE FISSION OF ^{238}U WITH 63.5 MeV ^{4}He IONS. Viola, V. E. Jr. (Univ. of Maryland, College Park); Minor, M. M.; Salwin, A. E.; Bondelid, R. O.; Theus, R. B. Contract AT(40-1)-3783. Nucl. Phys.; A174: No. 2, 321-37(1971).

Position-sensitive semiconductor detectors have been used to measure both in-plane and out-of-plane angular correlations for binary fission events from 63.5 MeV ^{4}He ion-induced fission of ^{238}U. From these data a value of 7.5 ± 1.0% has been derived for the contribution of direct interaction mechanisms to the total fission cross section at 63.5 MeV. When this result is included with recent theoretical expressions, the interpretation of fission fragment angular distribution data is found to be consistent with both theory and low-energy results up to this energy. The most probable total kinetic energy release was found to be 173.3 ± 5.4 MeV for the compound nucleus ^{242}Pu. The measured variations in the average fission fragment kinetic energies and the widths of the fragment spectra as a function of correlation angle are interpreted in terms of effects arising from direct interactions, neutron evaporation and the reaction kinematics. (auth)

6065 FINE STRUCTURE IN ISOBARIC ANALOGUE RESONANCES. Richard, Patrick; Moore, C. F.; Fox, J. D. (Florida State Univ., Tallahassee). Nucl. Phys.; A174: No. 2, 273-300 (1971).

Isobaric analog resonances in nuclei near mass-90 exhibit observed total widths of approximately 50 keV. This paper is concerned with the observation of fine structure of the order of 3 keV near the isobaric analog resonances. These measurements consist of excitation functions over the 5.3 and 5.9 MeV s-wave resonances in proton elastic scattering on ^{92}Mo and ^{90}Zr, respectively. In both cases the neutron exit channel is closed and other competing reactions are relatively unimportant. It is found that the magnitude of the fine structure becomes about 25% of the average cross section on resonance and fades away off resonance. The variation of the magnitude of the fine structure is asymmetric with respect to the resonance energy. The cross section averaged over the fine structure has been analyzed using an optical-model-plus-single-level formula. It is found that both resonances exhibit a large spreading width, which is a measure of the absorption of protons out of the isobaric analog state into the more complicated states which are essentially degenerate with the analog state. The asymmetry of

the fluctuations away from the average is explained in terms of the Robson "external" mixing formulation. (auth)

6066 PROPERTIES OF NEUTRON-DEFICIENT ODD-MASS POLONIUM ISOTOPES. Jonson, B. (CERN, Geneva); Alpsten, M.; Appelqvist, A.; Astner, G. Nucl. Phys.; A174: No. 2, 225-50(1971).

The isotopes ^{201,203,205}Po have been studied, using mass-separated radioactive sources produced at the ISOLDE facility at CERN. Several low-lying states were established in an α-γ coincidence experiment using sources of ^{205,207,209}Rn. For ^{205}Po a level scheme involving ten well-established excited levels has been obtained from a study of the ^{205}At EC-β^+ decay. In ^{201,203}Po M4 transitions of energies 417 and 641 keV respectively have been found. Including also recent data for ^{207,209}Po some systematic features are observed: The energies of the one-quasiparticle neutron levels $3p_{\frac{1}{2}}$, $2f_{\frac{5}{2}}$, $3p_{\frac{3}{2}}$ and $1i_{\frac{13}{2}}$ vary smoothly between isotopes and are very similar in corresponding lead isotones. Several levels of phonon character are also observed. The reduced transition probability for the M4 transition in ^{201}Po is determined to B(M4) = 900 $e^2 \cdot fm^8$, which is approximately only half of that observed in the lead isotopes. In ^{205}Po a 310 ± 60 ns half-life was observed in a delayed-coincidence experiment. Interpreted as the $p_{\frac{1}{2}} \rightarrow f_{\frac{5}{2}}$ neutron quasiparticle E2 transition, it is retarded with a factor of 25. (auth)

6067 PROJECTILE POLARIZATION IN THE COULOMB BREAKUP OF ^{6}Li. Disdier, D. L. (Chalk River Nuclear Labs., Ont.); Ball, G. C.; Haeusser, O.; Warner, R. E. Phys. Rev. Lett.; 27: No. 20, 1391-3(15 Nov 1971).

The reaction ^{208}Pb(^{6}Li, αd)^{208}Pb was studied at $E_{^6Li}$ = 24 and 27 MeV by observing d-α coincidences for particles emitted into the same solid angle. At $E_{^6Li}$ = 24 MeV the reaction proceeds predominantly by a sequential process of Coulomb excitation of the 2.184-MeV, $J^\pi = 3^+$ state, followed by breakup into α and d. When the strong dipole polarization of the ^{6}Li projectile is taken into account, a B(E2; $1^+ \rightarrow 3^+$) = 24^2_{ϵ} fm^4 is found, in good agreement with a recent (e,e') experiment. (auth)

6068 INELASTIC DECAY OF ANALOG RESONANCES WITH DIRECT REACTION BACKGROUND. Arking, R.; Boyd, R. N.; Lombardi, J. C.; Robbins, A. B.; Yoshida, S. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 27: No. 20, 1396-9(15 Nov 1971).

A combination of direct (distorted-wave Born-approximation) and resonance scattering terms is used to represent the reaction ^{124}Sn(p,p') to the 2^+ collective excited state in the region of the $\frac{7}{2}^-$ analog resonance at an incident energy of 10.65 MeV. Fits to on- and off-resonance cross sections and analyzing-power angular distributions yield spectroscopic information about the parent state in ^{125}Sn, represented as single-particle neutron states coupled to the 0^+ ground state and the 2^+ collective core state of ^{124}Sn. (auth)

6069 EFFECT OF THE IMPERFECTLY CLOSED PROTON SHELL IN ^{90}Zr ON ELASTIC ELECTRON SCATTERING. Negele, J. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett.; 27: No. 19, 1291-3(8 Nov 1971).

Although density-dependent Hartree-Fock theory based on a realistic interaction with essentially no free parameters yields satisfactory agreement with elastic electron scattering for reasonably well-closed shell nuclei like ^{40}Ca and ^{208}Pb, an additional correction arises in the case of an imperfectly closed shell. Inclusion of this correction term in ^{90}Zr significantly improves agreement with experimental data. (auth)

6070 ELECTRON-CAPTURE AND β-DECAY OF ^{122}Sb ORIENTED IN IRON. Krane, K. S.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 4, 1329-33(Oct 1971).

Angular distributions have been measured of γ radiations emitted in the decay of ^{122}Sb nuclei oriented at low temperatures in an iron lattice. Angular momentum admixtures in the (first forbidden) β radiation fields have been deduced; results indicate that the component of the radiation field carrying away two units of angular momentum contributes to the electron-capture decay to ^{122}Sn with at least twice the magnitude as to the β^- decay to ^{122}Te. These results are interpreted in terms of particle-hole correlations in the nuclear shell model. In addition, the E2/M1 mixing ratio of the 691-keV γ transition in ^{122}Te is deduced to be −2.90 ± 0.25. (auth)

6071 DECAY SCHEME OF 2.71 h ^{92}Sr. Parsa, B.; Ashari, A.; Goolvard, L.; Nobar, Y. M. (Tehran Univ. Nuclear Centre). Nucl. Phys.; A175: No. 3, 629-40(1971).

Gamma rays emitted in the decay of 2.71-h ^{92}Sr were investigated with a Ge(Li) detector. Sources were prepared by separating Sr from fission products. A total of 10 γ rays were attributed to the decay of ^{92}Sr in a complex spectra with interferences from ^{91}Sr and ^{92}Y. Gamma-gamma coincidences in the decay of ^{92}Sr were observed with a NaI(Tl)-Ge(Li) setup. The decay scheme of ^{92}Sr was constructed, this work involving placement of 8 of the γ rays emitted between ^{92}Y excited states at 241.4, 892.8, 953.3, and 1383.9 keV. The observed level structure is compared with previously reported predictions based on effective interaction calculations. The value for the half-life of ^{92}Sr was determined to be 2.71 ± 0.01 h. (auth)

6072 DECAY OF THE 79.5 keV LEVEL IN ^{134}I. Berg, V.; Hoeglund, A. (Univ. of Stockholm. Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Phys.; A175: No. 3, 495-500(1971).

The decay of ^{134}Te was investigated using a Ge(Li) detector and a double-lens coincidence spectrometer. Four new transitions were found. The half-lives of the lowest excited levels in ^{134}I were measured with the following results: $T_{\frac{1}{2}}$(79.5-keV level) = 1.62 ± 0.10 nsec, $T_{\frac{1}{2}}$(181.1-keV level) < 100 psec, $T_{\frac{1}{2}}$(210.8-keV level) < 150 psec. A comparison with theory confirms that the ^{134}I ground state configuration is predominantly $(g_{\frac{7}{2}}, d_{\frac{5}{2}})$. (auth)

6073 DECAY OF ^{201}Pb. Hnatowicz, V.; Kristak, J.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A175: No. 3, 539-44(1971).

Fifty-five γ rays were observed in the decay of ^{201}Pb, and levels in ^{201}Tl are indicated at 1134.87, 1130.24, 1419.96, 1639.52, and 1671.99 keV. Conversion coefficients are calculated for many of the transitions and compared with earlier results. Spin and parity assignments to the levels of ^{201}Tl are made on the basis of the multipolarity of de-exciting transitions. A level scheme is proposed. (auth)

6074 COULOMB REORIENTATION OF 2^+ STATES IN ^{32}S AND ^{112}Cd. Haeusser, O.; Alexander, T. K.; McDonald, A. B.; Diamond, W. T. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A175: No. 3, 593-605(1971).

The static quadrupole moments of the first excited states in ^{32}S and ^{112}Cd were measured using a 100-MeV ^{32}S beam. The results are interpreted in terms of the reorientation effect in Coulomb excitation and yield Q(^{32}S, 2232 keV) = −0.175 ± 0.050 b and Q(^{112}Cd, 617 keV) = $-0.40^{+0.13}_{-0.20}$ b, provided the signs of E2 matrix elements are chosen according to an anharmonic model. The B(E2)($0^+ \rightarrow 2^+$) values were measured to be 0.0284 ± 0.0020 $e^2 \cdot b^2$ and 0.52 ± 0.02 $e^2 \cdot b^2$, respectively. The results indicate that ^{32}S deviates strongly from a purely vibrational nucleus. (auth)

6075 EXCITATION OF ISOBARIC ANALOGUE STATES IN MESON-INDUCED NUCLEAR REACTIONS. Bressani, T. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Riv. Nuovo Cim.; 1: No. 2, 268-308(Apr-Jun 1971).

Excitation of isobaric analog states by means of meson beams is reviewed. The isobaric analogs of the giant resonance states are first discussed. The dipole oscillations of nuclei and theoretical predictions concerning μ^- and π^- radiative capture by nuclei are considered, and experimental results in μ^- capture and in π^- radiative capture are summarized. The possibility of studying the $T^{(3)} = T_0 + 1$ analogs of the giant dipole states in μ^- and π^- radiative capture by nuclei has been clearly demonstrated. The results are generally in reasonable agreement with the theoretical predictions. On the contrary, the excitation of the analogs of the giant quadrupole states, which has been predicted to play an important role for the radiative capture of π^- from 2p states, has not been observed. Strangeness analog states, in which a Λ particle replaces a nucleon in a nuclear parent ground state, are defined; and an experimental setup to study the strangeness analog states by means of the reaction $K^- + {}^A_Z X \rightarrow {}^A_Z X_\Lambda + \pi^-$ is described. (70 references) (R.W.R.)

6076 LIFETIMES OF 2^+ AND 4^+ STATES IN ^{160}Dy AND SOME SYSTEMATIC PROPERTIES OF EVEN RARE-EARTH ISOTOPES. Abou-Leila, H. (Ein Shams Univ., Cairo); Abd El-Haliem, A.; Darwish, S. M. Nucl. Phys.; A175: No. 3, 663-72(1971).

The half-lives of the 2^+ and 4^+ excited states in ^{160}Dy were measured by means of the delayed coincidence method. By using a magnetic double-lens coincidence spectrometer and a time-to-pulse height converter coupled to a fast-slow coincidence system, the half-lives of these levels were measured to be $T_{\frac{1}{2}}(2^+ \rightarrow 0^+)$ = 1.97 ± 0.04 msec and $T_{\frac{1}{2}}(4^+ \rightarrow 2^+)$ = 101 ± 9 psec. The experimental ratios of B(E2; $4^+ \rightarrow 2^+$)/B(E2; $2^+ \rightarrow 0^+$) and the moments of inertia are deduced and discussed for the even rare-earth isotopes of Sm, Gd, Dy, Er, Yb, Hf, W, and Os as a function of the neutron number. (auth)

6077 DECAY OF THE $13/2^+$ ISOMERIC STATE AND THE STRUCTURE OF THE LOW-LYING STATES IN ^{199}Hg. Kalish, Rafael (Technion-Israel Inst. of Tech., Haifa); Gal, Avraham. Nucl. Phys.; A175: No. 3, 652-62(1971).

The decay modes of the $13/2^+$ isomeric state (532 keV, $T_{\frac{1}{2}}$ = 43

min) of ^{199}Hg to the $^{5}/_{2}^{-}$ state at 158 keV and to the $^{5}/_{2}^{-}$ state at 413 keV were determined from the relative intensities of the 374-keV ($^{13}/_{2}^{+} \rightarrow {}^{5}/_{2}^{-}$) and 413-keV ($^{5}/_{2}^{-\prime} \rightarrow {}^{1}/_{2}^{-}$) γ rays as observed in a Ge(Li) detector. The data obtained from the present experiment regarding the M4 transition rates, together with the E2 and M1 rates determined from previous Coulomb excitation experiments on ^{199}Hg, are analyzed in terms of a modified core-excitation model. The four lowest excited states in ^{199}Hg are described in this model as a $p_{\frac{1}{2}}$ neutron coupled to the 2^{+} and $2^{+\prime}$ states of the doubly even Hg neighboring nuclei with some small extra single-particle contributions. (auth)

6078 SYMMETRY PROPERTIES OF THE SCATTERING AMPLITUDE AND THE SPIN DEPENDENCE OF THE DEUTERON–NUCLEUS INTERACTION. Hooton, D. J. (Univ. of Auckland, N. Z.); Johnson, R. C. Nucl. Phys.; A175: No. 3, 583-92(1971).

The implications of rotation, time reversal, and reflection invariance for the elastic scattering of a spin-s particle by a spin-zero particle are discussed in terms of the properties of the scattering amplitude. It is shown how these properties can be used to suggest experiments with polarized deuterons that are expected to be particularly sensitive to the presence of 2nd-rank tensor forces. (auth)

6079 ANGULAR DISTRIBUTIONS OF ^{238}U PHOTOFISSION FRAGMENTS. Dowdy, E. J.; Krysinski, T. L. (Texas A and M. Univ., College Station). Nucl. Phys.; A175: No. 3, 501-12 (1971).

Angular distributions of fragments from the photofission of ^{238}U were measured for discrete excitation energies in the range 5.6 to 9 MeV. Monoenergetic γ rays from radiative neutron capture were used to produce the excitation, and solid-state particle-track recorders were used as fragment detectors. From the measured angular distributions, the barrier heights and curvatures for three low-energy fission channels in the transition state nucleus are deduced. (auth)

6080 PRESENT STATUS OF ATOMIC MASS DETERMINATION. Duckworth, H. E. (Univ. of Manitoba, Winnipeg). pp 26-38 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Developments in atomic mass determination in the last few years are surveyed. Mass spectrometric techniques, mass data from nuclear physics, the 1964 mass table, mass spectroscopic work since 1964, and the preparation of a new mass table are discussed. (J.W.R.)

6081 ATOMIC MASS MEASUREMENTS OF THE LIGHT RARE EARTHS. Hudson, M. C. (Univ. of Minnesota, Minneapolis); Johnson, W. H. Jr. pp 495-500 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The University of Minnesota 16-inch double focusing mass spectrometer has been employed to measure a number of doublets in the region A = 146 to A = 164. These doublets involve the elements from neodymium to dysprosium. This work is part of a continuing program of measurements which now include mass determination for almost all stable isotopes up to A = 164 and also isotopes of lead and mercury. With the present results one can study nuclear binding energy systematics in the interesting region around neutron number N = 90 in more detail than has previously been possible. (auth)

6082 APPLICATIONS OF ELECTROMAGNETIC ISOTOPE SEPARATORS TO NUCLEAR PHYSICS. Nielsen, K. O. (Univ. of Aarhus, Denmark). pp 506-19 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The use of low-intensity electromagnetic isotope separators in nuclear physics is surveyed. The facilities for such research at the University of Aarhus are described. Some on-line isotope separator projects are also briefly described. The various applications of electromagnetic isotope separators in nuclear physics are discussed. (J.W.R.)

6083 MASS SPECTROMETRY STUDY OF RARE EARTHS PRODUCED BY NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Nguyen-Long-Den, de Saint Simon, M.; Bouissieres, G. (Institut de Physique Nucleaire, Orsay, France). pp 562-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Isotopes of rare earths produced by nuclear reactions induced by heavy ions were studied, using a mass spectrometer of great sensitivity and high stability with a thermionic ion source. During the irradiation, recoil products from the compound nucleus were collected directly on the filament of the mass spectrometer. About 10^{8} atoms of europium produced by nuclear reactions were studied by this method. The relative cross section of the reaction ^{139}La(^{12}C,xn)$^{151-x}$Eu at 86 and 90 MeV is determined for different values of x. An excellent agreement between these results and nuclear evaporation calculations by Jackson's method was obtained for nuclear temperatures of T = 2.25 MeV and 2.50 MeV. These values are greater than 1.2 MeV, value frequently adopted for the nuclear temperature of systems of little or no angular momentum. That points out angular momentum effects in reactions induced by heavy ions. (auth)

6084 SURVEY OF RESULTS OBTAINED WITH ISOTOPE-SEPARATOR-ON-LINE ARRANGEMENTS. Rudstam, G. (Swedish Research Councils, Studsvik). pp 567-75 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Some studies in nuclear physics conducted with isotope-separator-on-line arrangements are surveyed. Topics discussed include properties of separated samples, identification of new nuclides, spectroscopic investigations, total beta-decay energies, delayed nucleon emission, alpha-particle emission, gross properties of beta decay, spin and magnetic moments, and nuclear reaction studies. (J.W.R.)

6085 MASSES OF STABLE ISOTOPES OF THALLIUM. Demirkhanov, R. A.; Dorokhov, V. V. (Physical-Technical Inst., Sukhumi, USSR). pp 1301-6 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

Masses of ^{203}Tl and ^{205}Tl isotopes have been measured by the double focussing mass-spectrograph. The apparatus resolution was equal to 60,000–90,000. The measurements carried out have been widely checked from the point of view of "inner" accordance of results. Organic compounds of various compositions, masses of mercury isotopes and chlorides of orbium and thulium have been used as references. 26 doublets are measured as a whole. On measuring each doublet, the magnitude of ^{205}Tl – ^{203}Tl isotope "difference" has been determined. Masses of Tl isotopes have been measured within the relative accuracy of $\Delta M/M = 7.10^{-8}$. (auth)

6086 FISSION OF ^{232}Th INDUCED BY INTERMEDIATE-ENERGY ^{4}He IONS. Roginski, T. C.; Davis, M. E.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 4: No. 4, 1361-6(Oct 1971).

The cross sections for 34 nuclides covering the mass range 24 to 199 formed from the ^{4}He ion-induced fission of ^{232}Th at 20–41 MeV have been determined radiochemically. The resulting mass-yield curve clearly indicates contributions from at least three different types of fission: the symmetric binary, asymmetric binary, and asymmetric ternary modes. The identification of very light fragments and the low limits set on ^{199}Au confirm the existence of ternary fission seen previously in this laboratory in plutonium compound nuclei. Certain similarities and differences in this fissioning system to other heavier elements are discussed. (auth)

6087 EXCITED STATES OF ^{174}Hf FROM THE DECAY OF ^{174}Ta. Gillin, M. T.; Peek, N. F. (Univ. of California, Davis). Phys. Rev., C; 4: No. 4, 1334-44(Oct 1971).

The ^{174}Ta activity was produced via the ^{175}Lu(α,5n)^{174}Ta reaction with 66-MeV α particles from the Crocker Nuclear Laboratory 76-in. isochronous cyclotron. After removal of the ^{18}F, the half-lives were deduced by direct measurements. The half-lives of approximately 200 transitions, ranging in energy from 60 to 3000 keV, were identified using Ge(Li) detectors. Over 95% of these lines were assigned to ^{176}Hf, ^{175}Hf, or ^{173}Lu. The half-life of ^{174}Ta was measured to be 71.5 ± 6.5 min. Ge(Li)-NaI coincidence work has been done. The conversion-electron spectrum was first measured using a 3-mm Si(Li) detector with a cooled field-effect transistor and then using the same type of detector plus a magnet. The energies and γ intensities of the 100 transitions attributed to the decay of ^{174}Ta were measured. 32 conversion coefficients were determined. 16 levels with spins and parities are proposed on the basis of γ intensities, coincidence information, and conversion coefficients. 16 more levels are proposed on the basis of energy

sums. Spins and parities for four of these levels are suggested. 60 transitions are placed in the decay scheme. A very strong β feed to the 4+ level of the ground-state rotational band was observed. M1 enhancement in the β vibrational bands and K-forbidden γ transitions are discussed. (auth)

6088 SEARCH FOR THE DOUBLE BETA DECAY OF ^{150}Nd USING A MAGNETIC SPECTROMETER. Smith, Gary R. (Case Western Reserve Univ., Cleveland). Phys. Rev., C; 4: No. 4, 1344-52(Oct 1971).

A large-aperture low-resolution magnetic spectrometer was constructed to search for the double β decay of ^{150}Nd. The spectrometer was operated for approximately 750 h in the low-background environment of a salt mine, 585 m below ground level. The observed count rate is consistent with a lower limit for the half-life of 5×10^{18} yr for the decay of $^{150}Nd \rightarrow {}^{150}Sm + 2e^- + 2\bar{\nu}_e$ and 7×10^{18} yr for the mode $^{150}Nd \rightarrow {}^{150}Sm + 2e^-$. (auth)

6089 DECAY OF A NEW ISOMER IN ^{154}Tb TO HIGH-SPIN LEVELS IN ^{154}Gd. Riedinger, L. L.; Sousa, D. C.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 4: No. 4, 1352-6(Oct 1971).

Radioactive sources of ^{154}Tb made by the ^{153}Eu(α,3n) and ^{155}Gd (p,2n) reactions have been studied with Ge(Li) and Si(Li) detectors. A new isomer ($T_{\frac{1}{2}}$ = 22.5 ± 1.5 h; spin and parity probably 7$^-$) has been found in ^{154}Tb. This state decays primarily to an $I^\pi K = 7^-7$ isomeric state at 2137.8 keV in ^{154}Gd. Quasiparticle configurations involving the $11/2^-[505]$ neutron orbital are proposed for both of these isomeric states, and retardation factors are determined for transitions from the 2137.8-keV state. (auth)

6090 SEARCH FOR EVIDENCE OF TERNARY FISSION INDUCED IN ^{197}Au, ^{209}Bi, AND ^{239}Pu BY INTERMEDIATE-ENERGY HELIUM IONS. Uhl, D. L.; McDaniel, T. L.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 4: No. 4, 1357-61(Oct 1971).

Data have been obtained from radiochemical studies which indicate that ternary fission has been induced in ^{209}Bi and ^{239}Pu with intermediate-energy (≤60-MeV) helium ions. ^{28}Mg, a nuclide prominent in the ternary fission of ^{238}U, was used as a semiquantitative monitor for the ternary process. The low limit set for ^{47}Ca in these fissioning systems also substantiates the ternary-fission-product nature of ^{28}Mg. No evidence was found for the formation of ^{28}Mg in ^{197}Au irradiated with helium ions until excitation energies ≤64 MeV were used, but at these energies the yields of ^{47}Ca were greater than the yields of ^{28}Mg. These observations are consistent with the postulated change in the nature of the saddle-point shapes of lower-Z nuclides having a fissionability parameter, x, ≤0.67. (auth)

6091 EXPERIMENTAL SEARCH FOR HIGHER-ORDER EFFECTS IN K-, L-, AND M-SHELL E2 CONVERSION-ELECTRON PARTICLE PARAMETERS IN ^{154}Gd. Trueblood, J. H.; Avignone III, F. T. (Univ. of South Carolina, Columbia). Phys. Rev., C; 4: No. 4, 1490-3(Oct 1971).

The K-, L-, and M-shell particle parameters of the 123-keV transition in ^{154}Gd were determined by measuring the γ_{1274}-K_{123} (-L_{123}, -M_{123}) and the γ_{1274}-γ_{123} directional correlations in the same solid, isotopically separated source of ^{154}Eu, under the same conditions. The results are $b_2(K) = 1.91 \pm 0.08$, $b_2(L) = 1.25 \pm 0.07$, and $b_2(M) = 1.22 \pm 0.08$. These values are in good agreement with current first-order theory. The directional-correlation attenuations were found to depend on the length of time the europium oxide source was under vacuum, which might explain some of the anomalies in earlier reported values. The γ-K correlations were measured using an iron-encased high-transmission-lens spectrometer. (auth)

6092 ADIABATIC DEUTERON MODEL AND THE ^{208}Pb(p,d) REACTION AT 22 MeV. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 4: No. 4, 1485-8(Oct 1971).

It is shown that the adiabatic treatment of deuteron breakup during stripping reactions proposed by Johnson and Soper is able to explain the results obtained previously for the ^{208}Pb(p,d) reaction at 22 MeV without the use of an arbitrary radial cutoff. Some discussion is also given of the sensitivity of the predictions to the parameters of the model. (auth)

6093 EVIDENCE FOR INTERMEDIATE-STATE STRUCTURE FROM RESONANCE NEUTRON CAPTURE IN ^{185}Re AND ^{187}Re. Stolovy, A.; Namenson, A. I.; Godlove, T. F. (Naval Research Lab., Washington, D. C.). Phys. Rev., C; 4: No. 4, 1466-72(Oct 1971).

Measurements have been made on the high-energy capture γ rays associated with neutron resonances in the target nuclides ^{185}Re and ^{187}Re using an integral bias level of 4 MeV. The ^{187}Re data show nonstatistical behavior, indicating the influence of at least one extremely narrow intermediate state, with a width of only about 30 eV. (auth)

6094 SYSTEMATICS OF SPONTANEOUSLY FISSIONING ISOMERS. Britt, H. C.; Burnett, S. C.; Erkkila, B. H.; Lynn, J. E.; Stein, W. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 4, 1444-65(Oct 1971).

Excitation functions have been measured for the production of fission isomers by (α,xn) reactions for bombarding energies of 20–29 MeV and by (d,2n), (d,p), and (d,pn) reactions for bombarding energies of 9–14 MeV. Excitation functions for (α,xn) reactions were measured for targets of ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{242}Pu, and ^{244}Pu. Excitation functions for deuteron reactions were measured for targets of ^{235}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu, and ^{243}Am. New or more accurate half-lives were determined for the following fission isomers: ^{235m}Pu, 30 ± 5 nsec; ^{238m}Pu, 6.5 ± 1 nsec; ^{240m}Pu, 3.8 ± 0.3 nsec; ^{241m}Cm, 15.3 ± 1 nsec; and ^{245m}Cm, 23 ± 5 nsec. Isomers in ^{242}Cm and ^{244}Cm were identified but their half-lives were too long for measurement with the present techniques. The results are analyzed with a statistical model using realistic level-density expressions with many parameters fixed by comparison with experimental measurements of neutron-fission cross sections, neutron-to-fission decay widths, spallation cross sections, and fission lifetimes. This model is applied to the presently measured excitation functions and the results obtained previously by other groups for (n,2n), (p,2n), and (γ,n) reactions. With this model fission-barrier parameters are determined for Pu, Am, and Cm isotopes. Inconsistencies in the results obtained by applying this model to experimental isomer excitation functions indicate the directions for future refinements. (auth)

6095 POPULATION OF FISSION ISOMERS IN ^{236}U BY THE (d,p) REACTION. Britt, H. C.; Erkkila, B. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 4, 1441-3 (Oct 1971).

Measurements have been made of the ratio of the cross section for producing a fission isomer by the (d,p) reaction to the cross section for the (d,pf) reaction as a function of a discriminator setting on the energy of the outgoing proton. For the ^{235}U(d,p)^{236m}U reaction the results give isomer/prompt ratios of $(0.87 \pm 0.13) \times 10^{-4}$ for all excitation energies less than 7.5 MeV and $(2.05 \pm 0.25) \times 10^{-4}$ for excitation energies less than 6.0 MeV. The value obtained for the half-life of the ^{236m}U isomer is $T_{\frac{1}{2}} = 130 \pm 15$ nsec. (auth)

6096 DECAY OF ^{136}Pr AND THE LEVEL STRUCTURE OF ^{136}Ce. Ketelle, B. H.; Brosi, A. R.; Van Hise, J. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 4: No. 4, 1431-40(Oct 1971).

A new isotope with a 13.1 ± 0.1-min half-life has been assigned to ^{136}Pr. It has been produced by the reactions ^{136}Ce(p,n)^{136}Pr and ^{136}Ce(d,2n)^{136}Pr. It decays by electron capture and positron emission to excited states in ^{136}Ce. It has a capture-to-positron ratio of 0.65 ± 0.01 and a total decay energy of 5120 ± 70 keV. The energies and intensities of 63 γ rays have been measured. Conversion coefficients of the 540- and the 552-keV transitions have been found to be 6.5×10^{-3} and 6.8×10^{-3}, respectively. γ-γ coincidences have been measured using two 40-cm^3 Ge(Li) detectors from which an energy-level diagram for ^{136}Ce has been deduced. Spin and parity assignments have been made to many of the levels. The low-lying energy levels have been separated into quasi-ground and quasi-γ bands. (auth)

6097 E2/M1 MULTIPOLE MIXING RATIOS OF GAMMA TRANSITIONS IN THE QUASISPHERICAL NUCLEUS ^{132}Xe. Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 4: No. 4, 1419-31(Oct 1971).

The E2/M1 multipole mixing ratios $\delta(\gamma) = \langle I_f || \sum_N \vec{A}_2^{(E)} || I_i \rangle / \langle I_f || \sum_N \vec{A}_1^{(M)} || I_i \rangle$ of 10 γ transitions in the quasispherical nucleus ^{132}Xe have been measured by means of γ-γ directional correlations observed with two coaxial Ge(Li) detectors. Spin assignments have been made for the levels at 1963 keV (4^+), 2110 keV (4^+), 2112 keV (6^+), 2395 keV (4^+), 2584 keV (5^+), 2589 keV (3), 2614 keV (4^+), and 2839 keV (5^+). In addition, previous spin assignments for levels below 1900 keV were confirmed. Based on the proposed spin assignments, the following values of the quadrupole-dipole mixing ratios were obtained (energies in keV): $\delta(506) = -1.3 \pm 0.4$, $\delta(523) = -0.25 \pm 0.15$, $\delta(630) = 5.3$, $\delta(727) = -0.32 \pm 0.04$, $\delta(955) = -0.15 \pm 0.05$, $\delta(1136) = +0.9 \pm 0.3$, $\delta(1143) = -(0.04)$, $\delta(1173) = -0.40 \pm 0.15$, $\delta(1291) = +0.01 \pm 0.08$, and $\delta(1399) = +0.07 \pm 0.02$. The results are discussed in terms of the collective vibrational model and in terms of a quasirotational model. However, these models are of limited value in explaining the experimental data concerning the level structure and multipole transitions of ^{132}Xe. (auth)

6098 STATISTICAL α-PARTICLE EMISSION FROM PROTON BOMBARDMENT OF ^{197}Au. Gadioli, E.; Iori, I.; Molho, N.; Zetta, L. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Phys. Rev., C; 4: No. 4, 1412-19(Oct 1971).

Angular distributions of α particles emitted in the reaction $^{197}Au(p,\alpha)$ have been measured for proton energies in the interval 20–42 MeV. From the analysis of backward-angle spectra the statistical contribution to the reaction has been evaluated. Statistical theory appears to be able to predict the absolute value of this contribution. The analysis is consistent with the results one obtains from the study of (p,xn) reactions in heavy nuclei. (auth)

6099 SPONTANEOUS FISSION OF ^{240}Pu: COMPARISON WITH THE SLOW-NEUTRON-INDUCED FISSION OF ^{239}Pu. Toraskar, Jayashree; Melkonian, E. (Columbia Univ., New York). Phys. Rev., C; 4: No. 4, 1391-8(Oct 1971).

Fission-fragment mass and kinetic energy distributions have been obtained for the spontaneous fission of ^{240}Pu and compared with those for the thermal-neutron-induced fission of ^{239}Pu reported previously. Surface-barrier detectors were used for the simultaneous measurements of energies of both the fission fragments. Absolute fragment energies were calculated by using mass-dependent pulse-height energy relations. The measured average total kinetic energies were found to be 177.3 ± 1.5 MeV and 173.0 ± 1.5 MeV for the spontaneous and the induced fission, respectively, and the average pre-neutron total kinetic energies were 178.9 ± 1.5 MeV and 175.2 ± 1.5 MeV, respectively. The measured mass distribution for the spontaneous fission appears to be significantly different in shape from that for the induced fission. (auth)

6100 NEUTRON-HOLE-STATE STRUCTURE IN N = 81 NUCLEI. II. ^{140}Ce AND ^{138}Be(p,d). Jolly, R. K.; Kashy, E. (Michigan State Univ., East Lansing). Phys. Rev., C; 4: No. 4, 1398-1411(Oct 1971).

In continuation of the program of neutron-hole-state studies in N = 81 nuclei, angular distributions of deuterons from (p,d) reactions (energy resolution ~35 keV) on ^{140}Ce and ^{138}Ba at E_p = 35 MeV have been measured and compared with distorted-wave Born-approximation calculations including finite-range and nonlocality corrections. These calculations yield acceptable spectroscopic factors and are in fair agreement with the shapes of the experimental angular distributions. The neutron-single-hole energies have been determined. These energies (in MeV) are $d_{\frac{3}{2}}$, 0.0; $s_{\frac{1}{2}}$, 0.33; $h_{\frac{11}{2}}$, 1.07; $d_{\frac{3}{2}}$, 1.72; and $g_{\frac{7}{2}}$, 2.90 for ^{139}Ce; and $d_{\frac{3}{2}}$, 0.0; $s_{\frac{1}{2}}$, 0.54; $h_{\frac{11}{2}}$, 1.07; $d_{\frac{3}{2}}$, 1.71; and $g_{\frac{7}{2}}$, 2.93 for ^{137}Ba. Considerable fractionation of the $2d_{\frac{3}{2}})_{\nu}^{-1}$ and the $(1g_{\frac{7}{2}})_{\nu}^{-1}$ states is observed while the $(1h_{\frac{11}{2}})_{\nu}^{-1}$ and the $(3s_{\frac{1}{2}})_{\nu}^{-1}$ states are each observed to split mostly into two components. Systematics of the energies and strengths of the various neutron-single-hole states and their components are presented for all N = 81 nuclei from ^{137}Ba through ^{143}Sm and the significance of the systematics discussed. No measurable population of any neutron state in the 82 < N ≤ 126 major shell has been observed. (auth)

6101 MAGNETIC DIPOLE MOMENTS OF THE FIRST 2^+ STATES IN ^{192}Os AND ^{192}Pt; ROOM-TEMPERATURE NUCLEAR-MAGNETIC-RESONANCE MEASUREMENT OF THE Os HYPERFINE FIELD IN Fe AND Ni HOSTS. King, William C.; Grabowski, Z. W.; Scharenberg, R. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 4: No. 4, 1382-90(Oct 1971).

The magnetic dipole moments of the first 2^+ states in ^{192}Os and ^{192}Pt have been measured, using integral perturbed-angular-correlation (PAC) methods, to be μ = 0.797 ± 0.036 μ_N and μ = 0.90 ± 0.11 μ_N, respectively. Integral PAC measurements were performed using both Fe(Ir) and Ni(Ir) alloys, and it has been established that the Fe(Ir) alloy is not a suitable environment for a PAC experiment. Significantly, the results agree with the 2(Z/A) hydrodynamical values, but differ appreciably from the predictions of the Kumar and Baranger pairing-plus-quadrupole model. The room-temperature internal magnetic fields of ^{187}Os in Fe and Ni lattices have been measured by steady-state NMR methods to be $H_{int}(296°K)$ = −1093.43 ± 0.65 kOe and $H_{int}(295°K)$ = −282.3 ± 1.0 kOe, respectively. (auth)

6102 STUDY OF CHARGE-EXCHANGE COUPLING IN PROTON-INDUCED REACTIONS ON $^{95\ 98\ 100}$Mo AND $^{92\ 94}$Zr. Hinrichs, R. A.; Phillips, G. W.; Cramer, J. G.; Wieman, H. (Univ. of Washington, Seattle). Phys. Rev., C; 4: No. 4, 1366-74(Oct 1971).

The presence of isospin coupling in the incident channel has been been studied via proton-induced reactions on ^{95,98,100}Mo and ^{92,94}Zr. Anomalous behavior in the excitation functions at backward angles was observed in deuteron and proton outgoing channels. In the deuteron channels these anomalies, located near the (p,n) threshold to the ground-state analog, were, for almost all cases, similarly characterized by a double-dipped shape. Their strength is generally much weaker than the single minima observed in (d,p) reactions near mass 90 and can be categorized by the proton decay energy from the analog state formed in the charge-exchange process. The proton elastic excitation functions showed no structure near the (p,n) thresholds although the (p,p′) curves did exhibit fluctuations. (auth)

6103 p, 2p REACTION. James, A. N. (Univ. of Liverpool). pp 359-68 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The (p,2p) reaction at ~400 MeV is introduced from the point of view of the impulse approximation. Two high-energy protons emerge from the nucleus, which is left relatively near its ground state; the experiment picks out the kinematics appropriate for single interactions. The simple single interaction process takes place mainly in the surface region of nuclei. The DWIA theory of (p,2p) reactions is considered from the experimentalist's viewpoint. Some of the ideas are illustrated by reactions with ^{16}O. (R.W.R.)

6104 TOTAL REACTION CROSS SECTIONS FOR PIONS ON NUCLEI. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 395-7 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

A proposed experiment to measure the total reaction cross sections for π^+ and π^- mesons with ^{40}Ca, ^{12}C, ^{208}Pb, ^{58}Ni, and ^{120}Sn at 0.7 to 2.0 GeV is described. The aim of the measurements is to obtain further information on the distribution of neutrons in nuclei. (R.W.R.)

6105 DENSITY DISTRIBUTION OF NEUTRONS IN NUCLEI. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 397-403 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

The density distribution of neutrons in intermediate and heavy nuclei is considered. Although there is a rather large amount of uncertain information, neutron and proton distributions in nuclei must be roughly the same size. Information relevant to the problem can be found from the following sources: K^- meson capture, elastic nucleon scattering, high-energy pion absorption by nuclei, Coulomb displacement energies, K-mesic x rays, and single-particle-model calculations. (R.W.R.)

6106 ANGULAR CORRELATION OF FISSION FRAGMENTS AND PROMPT GAMMA RAYS. El-Mekkawi, L. S. (Atomic Energy Establishment, Cairo). Indian J. Pure Appl. Phys.; 9: No. 7, 470-2(Jul 1971).

The angular correlation of fission fragment and prompt gamma rays from thermal neutron fission was measured with respect to the fragment direction for the gamma channel width 0.49 to 0.65 MeV. Intensities of gamma rays were found to be higher in the direction of the fragment motion compared to those in the direction perpendicular to it. The anisotropy was found to be 17%. An apparent dependence of the anisotropy of the angular distribution of gamma emissions on the gamma energy due to the Doppler effect is also indicated. (auth)

Nuclear Theory

Refer also to abstracts 5131, 5159, 5680, 5740, 5783, 5837, 5839, 5962, and 5966.

6107 (ANL–7837, pp 1-52) MICROSCOPIC THEORY OF NUCLEUS–NUCLEUS INTERACTIONS. Greiner, Walter; Scheid, Werner (Frankfurt Univ. (West Germany). Institut fuer Theoretische Physik). Mar 1971.

From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

A phenomenological model for nucleus–nucleus scattering, an extended liquid-drop model, is developed and compared with experiment. The two-center shell model is used as a basis for a microscopic description of heavy-ion collisions. It is shown that nucleus–nucleus interactions, of both "sudden" and "adiabatic" types, allow the possibility of nuclear molecules. These can be formed because a few nucleons have—in the framework of the two-center shell model—joint orbitals in both wells. The gross structure at 21, 24, and 29 MeV in the ^{16}O–^{16}O elastic excitation function is attributed to the virtual resonances with l = 12, 14, and 16, respectively. These states lie above the molecular binding potential and can be excited directly. Quasi-bound states, lying within the molecular binding potential, are essentially excited only by means of a double resonance mechanism. The quasi-bound states give rise to the intermediate structure in the elastic scattering cross section. (R.W.R.)

6108 (ANL–7837, pp 199-228) COUPLED CHANNEL CALCULATIONS OF ELASTIC HEAVY ION SCATTERING. Rawitscher,

George H. (Connecticut Univ., Storrs). Mar 1971.
From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The rationale for using coupled equations to describe the nucleus–nucleus scattering process, instead of the optical model, is first explained. The coupled equations are written, and the results obtained from them are discussed, with emphasis on ^{16}O scattering by ^{16}O. The reflection coefficients are qualitatively analyzed in terms of the JWKB approximation. These calculations seem to require the coupling potential to be real, while theoretical reasoning would prefer a complex coupling; a possible resolution of this paradox is given. It is concluded that the presence of coupling gives rise to effects that are different from optical-model calculations: the values of the small reflection coefficients are substantially enhanced for the interior partial waves, and the angular distributions are shifted to smaller energies, relative to the optical-model results. The effect of the coupling on the cross section is strongly dependent on the Q value of the reaction and on whether the coupling potential is real or complex. Finally, it appears that the shape resonances present in the optical-model description of ^{16}O scattering by ^{16}O are not required if coupling is taken into account. (R.W.R.)

6109 (ANL–7837, pp 229-38) THEORETICAL CALCULATIONS OF THE INFLUENCE OF NUCLEAR DEFORMATION ON SCATTERING. Rasmussen, John O. (Yale Univ., New Haven, Conn.). Mar 1971.
From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The influence of quadrupole and hexadecapole nuclear deformation on the scattering of strongly absorbed projectiles (specifically, 50-MeV alpha particles by Sm targets) is described. The main features of the calculation are outlined; and the results presented. It is found that the nuclear phase shift necessarily gives rise to back-angle oscillations in the elastic cross section; the envelope is somewhat lower for deformed than for spherical nuclei, other parameters remaining the same. (R.W.R.)

6110 (ANL–7837, pp 239-63) ANGULAR MOMENTUM DEPENDENCE OF OPTICAL POTENTIALS OF COMPLEX NUCLEI. Robson, D. (Florida State Univ., Tallahassee. Dept. of Physics). Mar 1971.
From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

The $\alpha-\alpha$ system has long been described by a real potential with a strong l dependence. But the angular momentum dependence of the imaginary potential, particularly for heavy-ion scattering, is at least as important, as it produces very large changes from the standard optical potential. First, a brief account is given of the angular momentum dependence of optical operators. Calculations are done by using conventional optical potentials with a smooth but rapid angular momentum cutoff of the absorption potential strength. The results of including an l-dependent absorption are presented for the systems $^{16}O + ^{12}C$, $^{14}N + ^{12}C$, $^{14}N + ^{13}C$, $^{10}B + ^{12}C$, $^{19}F + ^{12}C$, and $^{16}O + ^{11}B$. Older work on $^{16}O + ^{16}O$ and α scattering by $A \sim 40$ nuclei is also briefly reviewed. It is concluded that the simple modification of the standard optical model to include a smooth cutoff in absorption for high angular momentum produces a consistent explanation of most of the available heavy-ion scattering data. This simple description of large back-angle cross sections, while not necessarily in conflict with the mass transfer ideology, does cast doubt on the importance of such mechanisms. Molecular states can occur, but presumably only in certain energy regions and only for high-angular momentum states. (R.W.R.)

6111 (ANL–7837, pp 265-82) REGGE POLES AND STRONG ABSORPTION IN HEAVY-ION SCATTERING. McVoy, K. W. (Brooklyn Coll., N. Y.). Mar 1971.
From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

Elastic angular distributions generated by realistic smooth-cutoff parametrizations of the η_l's have too low an intensity near 180°. One possible mechanism for this large, oscillatory back-angle scattering, shape resonances or "rotational quasi-molecular states" is discussed. A generalization of the Blair smooth-cutoff phase shift parametrization that may be capable of extracting shape-resonance information from a phase shift analysis at a single energy, or even from a single angular distribution in favorable cases, is described. Plots of the energy dependence of the transmission coefficients are given for various l's, with shape resonances appearing as maxima in the curves. A resonance with a given radial quantum number can occur in a range of different partial waves, its energy increasing as l increases, simply because of the increased rotational energy. Such a sequence of states or resonances differing only in rotational energy is called a set of Regge recurrences. Each resonance in the l dependence can be described by a one-pole or Breit–Wigner approximation in l, the single Regge-pole approximation. Study of the oscillatory regions of the angular distributions shows that the back-angle oscillations (glory effect) are almost entirely due to the Regge pole. (R.W.R.)

6112 (ANL–7837, pp 295-302) INTERACTION IN THE ELASTIC TRANSFER REACTIONS. Imanishi, Bunryu (Nihon Univ., Tokyo). Mar 1971.
From Symposium on heavy-ion scattering; Argonne, Ill. (25 Mar 1971).

When the nucleus B has a large reduced width for decomposition into b + c, the elastic transfer reaction a(B,B)a, where a is the same nucleus as b, can be used to study the nucleus B. In this reaction the chief processes are the elastic process, $a + (b + c) \rightarrow a + (b + c)$, and the transfer process, $a + (b + c) \rightarrow (a + c) + b$. The kinematics of this reaction is treated: only one state of the nuclei a and B is considered. (R.W.R.)

6113 (CONF-690217–(Ch.2), pp 178-97) GIANT RESONANCES AND ULTRAHIGH EXCITATION OF NUCLEI. Shapiro, I. S. 1969. (In Russian).
From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

Reactions proceeding through overlapping nuclear resonance yield sufficiently monochromatic beams of incident particles for precise analysis of reaction cross sections. Isolated resonance, and Fermi unitarity approximations are considered under the topic of giant resonances. The discussion of ultrahigh nuclear excitation includes N*-nuclei with many-nucleon resonances, state classification, and methods of generation. (K.S.W.)

6114 (CONF-690217–(Ch.2), pp 251-75) EXCITATION OF MANY-PARTICLE LEVELS OF NUCLEI DURING β-DECAY. PART II. Peker, L. K. 1969. (In Russian).
From fourth winter seminar on the theory of the nucleus and the physics of high energies; Leningrad, USSR (5 Feb 1969).

The special features of the excitation of many-particle levels in β-decay processes are discussed. In addition, it is recommended that all "anomalous" states be reconsidered in terms of their derivation from β-transition probability instead of interpreting them as $I = 7/2+$. Analysis of β-decay is discussed in relation to single-, two-, three- and four-particle levels. Multicomponent "anomalous" nuclear states and possible interpretation of "anomalous" levels are examined. In conclusion, attention is focussed on an example of four-particle level, type 3p,n : $^{90}_{41}Nb_{49}$, and an interpretation of various excitation levels is presented. (K.S.W.)

6115 (INR–1292) OCTUPOLE VIBRATIONS OF THE FISSIONABLE NUCLEI AT THE EQUILIBRIUM AND SADDLE POINT DISTORTIONS. Blocki, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1971. 89p. (In Polish). Dep. NTIS (U. S. Sales Only).

The octupole vibrational states of the fissionable nuclei were calculated assuming two different ferms of the octupole operator $r^3Y_{3\mu}$ and $\rho^2Y_{3\mu}$. The calculations were performed for several values of the quadrupole deformation ϵ of some actinide nuclei. A fairly good agreement between the results of these calculations at the equilibrium state and experimental data was observed. The investigation of octupole states as the ϵ function indicates the considerable differences between the $r^3Y_{3\mu}$ and $\rho^2Y_{3\mu}$ vibrations. The stability of heavy nuclei with respect to the octupole deformation and connection of the last with the fission process was discussed. (auth)

6116 (ITF–71–47–E) ON SUM RULES IN THE PERTURBATION THEORY. Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 17p. Dep. NTIS (U. S. Sales Only).

In the framework of perturbation theory for the system of three or four particles sum rules are obtained for the averages of physical values for the ground state. These sum rules remove the application of explicit form of high-excited states of unperturbed problem and can be used in calculating the ground-state energy, its r.m.s. radius and form-factors in the case of system of three and four nucleons. (auth)

6117 (JINR–P4–5982) PHENOMENOLOGICAL APPROACH TO ROTATIONAL EXCITED STATES. Dzholos, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

It was shown that various phenomenological formulas which describe the energies of rotational levels may be obtained within the framework of one given model. Using this model the relation between $E(0_2)/E(2_1)$ and $E(4_1)/E(2_1)$ was established. Experimental data were examined in the light of this relation. (tr-auth)

6118 (JINR-P4-6035) INTENSITIES OF TRANSITIONS IN ^{16}O. Mikhailov, I. N.; Nadzhakov, E.; Piperova, I.; Petrov, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

SU(3) group is used for the analysis of the probabilities of E2-transitions in ^{16}O. (auth)

6119 (LA-4739) VIXEN: A CODE TO CHECK PHYSICAL CONSISTENCY OF PHOTON-PRODUCTION DATA IN REVISED ENDF FORMAT. Dudziak, Donald J.; Romero, Johnny M. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 15p. Dep. NTIS.

The VIXEN code reads the neutron cross-section and photon-production data files in ENDF format, checking them for format syntax, consistency, and physical realism. The code is intended to help cross-section evaluators and reviewers produce an ENDF data set free of typographical, syntactical, and simple physics errors. Suspected errors are flagged on the output listing, and quantities useful to the reviewer (e.g., total photon energy released and average photon energy of a continuum) are listed. The code, written in FORTRAN 4, is presently operational on CDC 6600, CDC 7600, and IBM 360 computers, and requires a $42k_{10}$ core memory. It is available from the Radiation Shielding Information Center at Oak Ridge National Laboratory. 5 references. (auth)

6120 (NYO-4032-66) SHELL MODEL, QUARTETS AND CLUSTERS IN LIGHT NUCLEI. Arima, Akito (State Univ. of New York, Stony Brook. Dept. of Physics). [1971]. 18p. Dep. NTIS.

The topics discussed are shell model calculations of neon-20 and -22, spectroscopic factors and alpha-transfer reactions, quartet states, and the shell and cluster models of neon-20. (J.F.P.)

6121 (NYO-4270-1) DAMPING OF DEEP SINGLE-HOLE STATES IN NUCLEI. Hughes, T. A. (IBM Scientific Center, Houston, Tex.); Fallieros, S. (Brown Univ., Providence, R. I.); Goulard, B. (Laval Univ. (Quebec)). [1969]. 22p. Dep. NTIS.

Properties of single-hole states resulting from the elimination of a deeply bound nucleon from a nucleus are studied. The damping of these states, which reflects their coupling to more complex excitations, is calculated and the regularities in its mass dependence are discussed. Expressions exhibiting the mass-number dependence of the level density of two-hole-one-particle excitations and of the nuclear-interaction matrix elements are also obtained. (auth)

6122 (ORNL-TM-3632) MORSE-GEOM-MORSEC-SAMBO INPUT INSTRUCTIONS. Burgart, C. E. (Oak Ridge National Lab., Tenn.). 19 Nov 1971. 27p. Dep. NTIS.

The input instructions for the MORSE random walk, for slab, sphere, cylindrical and general geometries, and for the MORSEC cross section module and SAMBO analysis package were updated and are given in this memorandum for the purpose of convenience for the user. (auth)

6123 (ORO-3765-36) PROGRESS REPORT FOR THEORETICAL STUDIES IN NUCLEAR REACTIONS AND STRUCTURE. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sep 1971. Contract AT(40-1)-3765. 30p. Dep. NTIS.

Research progress for theoretical studies in nuclear structure and properties, nuclear reactions, and fission is reported. A list of publications and theses is included. (J.W.R.)

6124 GAS-LIQUID INSTABILITY IN THE MANY-FERMION SYSTEM AND THE BREAKDOWN OF PERTURBATION THEORY BASED ON THE PLANE-WAVE HARTREE-FOCK HAMILTONIAN. De Llano, M. (Univ., Mexico City); Tolmachev, V. V. Phys. Lett.; 37B: No. 1, 37-40(1 Nov 1971).

The unambiguous breakdown of a perturbation series for the ground-state properties of a quantum liquid of interacting fermions, based on an unperturbed single-particle Hamiltonian defined self-consistently in terms of plane-wave orbitals, is discussed and related to the gas-liquid phase transition. (auth)

6125 (d,p) REACTION ANOMALY AT THE THRESHOLD OF THE ANALOG CHANNEL AND THE p-WAVE NEUTRON STRENGTH FUNCTION. Graw, G.; Hategan, C. (Univ., Erlangen, Ger.). Phys. Lett.; 37B: No. 1, 41-3(1 Nov 1971).

The anomaly is discussed in terms of the averaged S matrix and the p-wave neutron strength function. It is shown that the neutron strength function determines the structure of the anomaly (single dip, double dip); and the (d,p) background, its form (symmetric, asymmetric). (auth)

6126 SOME EXACT RESULTS IN THE HARTREE-FOCK THEORY OF A MANY-FERMION SYSTEM AT HIGH DENSITIES. Lieb, E. H. (Massachusetts Inst. of Tech., Cambridge); De Llano, M. Phys. Lett.; 37B: No. 1, 47-9(1 Nov 1971).

For high particle densities sufficient conditions on the two-particle interaction are demonstrated such that the Hartree-Fock homogeneous-density (plane-waves) ground-state energy is exact, and that lower-energy, granular-density solutions may exist when the above conditions are violated. (auth)

6127 GENERATOR-COORDINATE PSEUDO-POTENTIALS RELATED TO THE OVERLAP AND THE KINETIC ENERGY OF LIGHT COLLIDING NUCLEI. Giraud, B.; Zaikine, D. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 37B: No. 1, 25-8(1 Nov 1971).

An analytic solution of the Hill-Wheeler equation applied to the scattering of light fragments yields pseudopotentials coming from nuclear overlap and kinetic energy. Their properties are estimated. (auth)

6128 SHELL-MODEL ASPECTS IN COUPLED CHANNEL CALCULATIONS USING FESHBACH PROJECTION TECHNIQUE. Barz, H. W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.); Rotter, I.; Hoehn, J. Phys. Lett.; 37B: No. 1, 4-6(1 Nov 1971).

Nucleon-nucleus scattering is described in the continuum shell-model theory treating the continuum-continuum coupling by projecting out the bound states and the single-particle resonances from the configuration space. The method is demonstrated by the analysis of the $^{15}N(n,n')$ reaction. (auth)

6129 PAIRING EFFECTS IN THE PROJECTED HARTREE-FOCK MODEL. Parikh, J. C. (Physical Research Lab., Ahmedabad, India); Castel, B. Phys. Lett.; 37B: No. 1, 7-8(1 Nov 1971).

A technique introducing pairing correlations in the projected Hartree-Fock model is described for a few f-p shell nuclei. It provides a good example of Marumori and Eichler's considerations [Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd.; 35: No. 7 (1966)] on the importance of pairing in producing nuclear deformation. (auth)

6130 POSSIBILITY OF SPIN-, ISOSPIN-, AND SPIN-ISOSPIN-QUADRUPOLE COLLECTIVE EXCITATION MODES IN NUCLEI. Lin, L. (State Univ. of New York, Albany); Chi, B. E.; Goswami, A. Phys. Lett.; 37B: No. 1, 21-4(1 Nov 1971).

The spin-, isospin-, and spin-isospin-quadrupole modes in spherical open-shell nuclei are studied through a modified-surface-delta-interaction model. (auth)

6131 CALCULATION OF SOME HIGHER-ORDER DIAGRAMS IN NUCLEAR MATTER. Dahlblom, T. K. (Univ. of Helsinki. Abo Akademi, Finland); Kouki, T. Nucl. Phys.; A175: No. 1, 45-57(1971).

Exchange diagrams of third and fourth order in perturbation theory are found to be important for long-range potentials of the one-pion-exchange type. The Bethe-Faddeev three-body energy is also recalculated for two different single-particle potentials, one of which is attractive for small particle-state momenta. (auth)

6132 OPTICAL-MODEL POTENTIAL AND SINGLE-PARTICLE RESONANCES. Cugnon, J. (Univ., Liege). Nucl. Phys.; A175: No. 1, 113-23(1971).

Two methods are described which lead to a definition of the optical-model potential when single-particle resonances are present. They are based on a modification of the single-particle potential. For one method, the properties of the modified potential are extensively discussed. (auth)

6133 ELASTIC SCATTERING OF PIONS ON LIGHT NUCLEI. I. A STUDY IN COORDINATE SPACE WITH KISSLINGER'S MODEL. Dedonder, J. P. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A174: No. 2, 251-72(1971).

The approximations introduced in Kisslinger's model are analyzed and it is suggested that some of these approximations may be removed without losing the simplicity of the model. Good fits for forward scattering at energies close to and above the 3-3 resonance were obtained. However, the fits become quite poor at low energies. (auth)

6134 METHOD OF GENERATOR COORDINATES: SYMMETRY-MIXING SOLUTIONS IN A SOLVABLE MODEL. Hadermann, J. (Univ., Bonn). Nucl. Phys.; A175: No. 3, 641-51(1971).

By means of the method of generator coordinates an exact differential eigenvalue equation for the nuclear many-body problem can be derived. A symmetry-mixing approximation is suggested which, when applied to a simple model, yields good results when all quantities are calculated in the complex space of generator coordinates. (auth)

6135 COLLECTIVE TREATMENT OF THE PAIRING HAMILTONIAN. II. CHARGE-INDEPENDENT FORCE: HAM-

ILTONIAN AND SYMMETRIES. Dussel, G. G. (Comision Nacional de Energia Atomica, Buenos Aires); Perazzo, R. P. J.; Bes, D. R.; Broglia, R. A. Contract AT(11-1)-1764. Nucl. Phys.; A175: No. 3, 513-27(1971).

A collective treatment of the problem of neutrons and protons interacting through a charge-independent pairing force is presented. The Hamiltonian is expressed in terms of six variables, four of them being angular variables defining orientations in isospace and gauge space, while the remaining two variables represent intrinsic deformation. The symmetries of the problem are discussed in terms of the solutions corresponding to the vibrational limit. (auth)

6136 SINGLE-PARTICLE STATES IN A NON-AXIALLY SYMMETRIC AVERAGE FIELD. Goetz, U.; Pauli, H. C.; Alder, K. (Univ., Basel). Nucl. Phys.; A175: No. 3, 481-94 (1971).

A fast numerical method for solving the independent-particle Schroedinger equation for nonaxially symmetric nuclei, which need not be symmetric with respect to a plane (P_3 type), is presented. The method is illustrated by numerical results for ellipsoidal shapes. (auth)

6137 NUCLEAR DENSITY DISTRIBUTIONS AND THE INCLUSION OF EXCHANGE IN INELASTIC SCATTERING FROM DEFORMED NUCLEI. Mackintosh, Raymond S. (Australian National Univ., Canberra). Nucl. Phys.; A175: No. 3, 528-38 (1971).

The lack of a comprehensive theory relating nuclear-shape calculations to deformation parameters evaluated in the analysis of various kinds of experiments is emphasized. The procedures of Greenlees [Phys. Rev., C; 2: 1063 (1970); Phys. Rev., 171: 1115 (1968)] and of Owen and Satchler [Phys. Rev., Lett., 25: 1720 (1970)] are formally generalized to deformed nuclei, and the various interactions are evaluated in terms of the nuclear density matrices. The general problem of exchange excitation of collective levels is also discussed. A method for folding in projectile size is mentioned, and a treatment of two interacting spheroids is presented. (auth)

6138 FISSION THRESHOLD ENERGIES IN THE ACTINIDE REGION. Pauli, H. C.; Ledergerber, T. (Univ., Basel). Nucl. Phys.; A175: No. 3, 545-55(1971).

The isospin dependence of the fissility parameter is determined from a fit of the outer fission barrier to the available experimental data. Shell and pairing corrections are taken into account by the Strutinsky procedure [Nucl. Phys., A95: 420 (1967); A122: 1 (1968)]. The energies of the stationary points of the deformation energy are compared with the experimental data, and a slight but systematic discrepancy is established. The theoretical fission thresholds reveal the magicity of the neutron number 152. (auth)

6139 INTERPRETATION OF RECENT DOUBLE BETA DECAY RESULTS. Shapiro, M. H. (Univ. of Rochester, N. Y.). pp 1307-11 of Recent Developments in Mass Spectroscopy. /Ogata, Koreichi (ed.). Baltimore; University Park Press (1970).

From Recent developments in mass spectroscopy conference; Kyoto, Japan (8 Sep 1969).

The best available experimental data on double beta decay is examined and interpreted with respect to the conservation of leptons. (J.W.R.)

6140 REAL AND VIRTUAL RADIATION IN ELECTRON–NUCLEUS SCATTERING. Gargaro, W. W.; Onley, D. S. (Ohio Univ., Athens). Phys. Rev., C; 4: No. 4, 1032-43(Oct 1971).

Expressions are developed for the virtual photon spectrum and for the bremsstrahlung cross section, using the distorted-wave method for relativistic electrons in a Coulomb field. Evaluation of the matrix elements is made in terms of generalized hypergeometric functions, and some numerical results are given for electrons of energy 10 and 100 MeV. Significant enhancement of the virtual radiation spectrum is found to result from the use of distorted waves as opposed to plane waves. Calculations of the contributions of E1, M1, E2, and E3 radiation to the bremsstrahlung cross section, $d^2\sigma/d\omega d\Omega$, are also made; enhancement, similar to that observed with the virtual spectrum, is found in this case also. (auth)

6141 CALCULATIONS WITH A 1s, Od SHELL MODEL FOR A = 34 to 38 NUCLEI. Wildenthal, B. H. (Michigan State Univ., East Lansing. Oak Ridge National Lab., Tenn.); Halbert, E.C.; McGrory, J. B.; Kuo, T. T. S. Phys. Rev., C; 4: No. 4, 1266-1314 (Oct 1971).

Results are presented of calculations made in the full space of sd-shell-model wave functions for positive-parity states in the nuclei with A = 34–38. Several different effective Hamiltonians were employed, some of which had two-body parts obtained by reaction-matrix techniques from the Hamada–Johnston scattering potential. The observables calculated were energy-level spectra, single-nucleon spectroscopic factors, and E2 and M1 moments and transition strengths. These calculations yield fair-to-good agreement with many of the observed nuclear-structure data in this mass region. (auth)

6142 MULTICONFIGURATIONAL SELF-CONSISTENT CALCULATION IN LIGHT DEFORMED NUCLEI. Ho-Kim, Q. (Univ. Laval, Quebec). Phys. Rev., C; 4: No. 4, 1077-86 (Oct 1971).

A variational method of calculating correlated intrinsic wave functions for deformed nuclei is formulated. The configuration amplitudes and the single-particle orbitals which define such wave functions obey a system of equations, which is solved self-consistently by an iterative procedure for the doubly even N = Z nuclei in the sd shell. The correlations under study are of the 2p-2h type. Compared with the independent-particle Hartree–Fock picture, the present solutions show a greater stability in terms of binding energy and shape symmetry. (auth)

6143 CONCEPT OF THE INTRINSIC STATE. Goss, David (Nebraska Wesleyan Univ., Lincoln). Phys. Rev., C; 4: No. 4, 1109-13(Oct 1971).

The problem of collective nuclear rotations is discussed in terms of a kinematic transformation to an intrinsic body-fixed coordinate system. Some results are obtained that are equivalent to the classical case. By use of approximate projection operators, an algorithm for calculating successively higher terms in the expansion of the rotational parameter ($\frac{1}{2}$ the inverse inertial moment) is developed. The first-order term is just the Skyrme formula, with the proviso that it be evaluated with respect to the "nonrotational" part of the Hamiltonian. (auth)

6144 ELASTIC ELECTRON SCATTERING AND SHORT-RANGE CORRELATIONS: REPLY TO THE NOTE BY M. FINK, H. HEBACH, AND H. KUEMMEL. Ciofi Degli Atti, C. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., C; 4: No. 4, 1473-6(Oct 1971).

The problem of how to compare the effects of Jastrow and Bethe–Goldstone correlations on the nuclear-charge form factors is discussed. It is shown that the conclusion recently drawn by some authors that these effects are very different is not well grounded. (auth)

6145 SCATTERING THEORY AT INTERMEDIATE ENERGIES. Wilkin, C. (University Coll., London). pp 1-42 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Five lectures are presented on scattering at intermediate energies. The derivation of the Glauber theory is first treated. Applications of the equations to physical problems are treated in the remaining lectures. (L.B.S.)

6146 PION–NUCLEUS INTERACTION. Ericson, T. E. O. (CERN, Geneva). pp 102-97 of Proceedings of the Banff Summer School on Intermediate Energy Nuclear Physics. /Neilson, G. C. (ed.). Edmonton, Alberta; Univ. of Alberta (1970).

Five lectures on the pion–nucleus interaction at low and intermediate energies (≤500 MeV) are presented. General properties of the pion are reviewed, and other topics discussed include scale factors and observables in the mesic atom, energy shifts and scattering lengths, and the nuclear Lorentz–Lorenz effect. A method for determining the nuclear neutron size, based on the π–N interaction, is pointed out. After completing a discussion of the theoretical aspects of pion reactions with nuclei at low energies, some features of the π–nucleus interaction that are directly connected to the structure of the nuclear pion field are considered. Comparison of theory with experiment shows that nuclear pion reactions are not yet completely understood. Pion production in nuclei by nuclear bombardment and the radiative capture of a pion by nuclei, the inverse of nuclear photoproduction of pions, are then treated. When a nuclear ground state that contains both nucleonic and pionic degrees of freedom is studied, it is necessary to consider the fluctuations of the system into all kinds of excited states virtually. The series ends with an application of forward dispersion relations to π–nucleus interactions. (R.W.R.)

REACTOR TECHNOLOGY

Commercial Power Reactors

6147 (BMBW-FBK-71-8) URANIUM SUPPLY AND PREPARATION AND DELIVERY OF FUEL ELEMENTS FOR THE FIRST CORE OF THE OBRIGHEIM REACTOR. Etzel, W.; Riedel, E. (Kraftwerk Union A.G., Erlangen (West Germany). Kernkraftwerk Obrigheim G.m.b.H. (West Germany)). Aug 1971. 32p. (In German). Dep. NTIS (U. S. Sales Only).

The first core fuel for the Nuclear Power Plant Obrigheim (KWO) is described. The manufacturing of the fuel assemblies is reviewed. The various steps in connection with the furnishing of the enriched uranium, the fuel assembly and its components, the manufacturing route including quality assurance and fabrication tests and the delivery of the fuel assemblies to the site are described. Reference is made to fabrication losses of uranium and the re-use of recovered fabrication scrap. (auth)

6148 (CONF-710218) PROCEEDINGS OF THE 12th ANNUAL AUA-ANL NUCLEAR ENGINEERING EDUCATION CONFERENCE, ARGONNE, ILLINOIS, FEBRUARY 1-2, 1971. Bradish, John (ed.) (Argonne National Lab., Ill.). 215p. Dep. NTIS.

Papers and discussions presented at the conference concerned the university's role in public understanding of nuclear power. Problems in informing the general public on the social, economic, and environmental impact of nuclear power plant construction and operation are examined. The need to educate the public on all technical aspects of nuclear power so that the public can make the decisions regarding possible applications is stressed. (H.D.R.)

6149 (FIND-50309(11-71)) FIND: MAINE YANKEE ATOMIC POWER STATION. Smith, James G. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 30 Nov 1971. 14p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

6150 (FIND-50366(11-71)) FIND: EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Revision 1. Smith, James G. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 15 Nov 1971. 8p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

6151 CONTROL INSTALLATIONS OF THE KKS. Aleite, W. (Siemens AG, Erlangen, Ger.); Bock, H.-W.; Dorer, K. Atomwirt., Atomtech.; 16: No. 11, 597-9(Nov 1971). (In German).

Installations for power control are discussed for the nuclear power plant Stade and technical advancements in comparison to the nuclear power station Obrigheim are described. Through constant control of mean temperature of the cooling medium, power of the reactor is adjusted to that of the generator. A control bank, to which belong most of the control rods, regulates the power. In the case of both sudden reduction in power demand and failure of cooling pumps, control of mean temperature of cooling medium can be supported through insertion of control rods. (tr-auth)

6152 HIGH VOLTAGE POWER SUPPLY AT THE KKS. Borst, A.; Breuker, H. (Kraftwerk Union AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 613-14(Nov 1971). (In German).

The power grid of the nuclear power plant Stade shows the conventional block design. Its most important components are two 380 MVA 3-phase current transformers for the power transmission, two 30 MVA transformers for plant supply, the generator conduits, and the plant supply hookup. A major part of the electrical installation serves for emergency current supply. The emergency current supply essentially consists of three diesel units with 2200 kVa each. In addition, several other independent grids are available. (tr-auth)

6153 REACTOR AUXILIARY AND SUPPORT INSTALLATIONS OF THE KKS. Bruhn, H. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 610-12(Nov 1971). (In German).

Safe operation of the reactor depends on auxiliary and support installations. They constitute two system groups of which one is directly connected with the primary cooling circuit while the other one is activated in case of failures for protection of both plant and environment. The first system group controls volume, supplies chemicals, and purified the cooling medium. The second system group comprises emergency cooling, emergency after-cooling, cooling, and sprinkler system in the reactor building. The two systems are described and presented in block diagrams. (H.B.G.)

6154 CONSTRUCTION TECHNIQUES FOR BUILDINGS AND MACHINES AT THE KKS. Sindelar, H. (Kraftwerk Union AG, Erlangen, Ger.); Schubersky, E. Atomwirt., Atomtech.; 16: No. 11, 605-9(Nov 1971). (In German).

In less than 20 months, 63800 m^3 of concrete and 7880 tons of steel were used in the construction of the nuclear power plant Stade. With respect to time, construction of the reactor building and installation of machines claimed priority. The site on the lower Elbe river caused foundation difficulties which were corrected. Special difficulties were encountered during construction of the external safety cylinder and installation of the cupola. Analyzed were pressure tests of the primary system and of the core. (tr-auth)

6155 PRIMARY COMPONENTS OF THE KKS REACTOR. Dorner, H.; Ruf, R. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 603-5(Nov 1971). (In German).

The primary system comprises the reactor pressure container, four symmetrically arranged cooling circuits, and the pressure sustaining system. With the exception of the pressure sustainer, all components were manufactured from the steel 22NiMoCr37. All surfaces touched by the primary medium are covered by corrosion-resistant stabilized austenite. Design pressure for primary water conducting parts is 178 atm; design temperature is 350°C. Described are stress resistance calculations for the primary circuit, production of the reactor pressure vessel, steam producer, pumps for cooling medium, and pressure sustainer. (H.B.G.)

6156 CONTROL CIRCUITS OF THE KKS. Bachmann, G.; von Haebler, D. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 600-2(Nov 1971). (In German).

Instrumentation of the nuclear power plant Stade was significantly improved in comparison to the nuclear power plant Obrigheim. Current was decreased from 220 V to 24 V and several single panels were centralized into one control panel. Improvements in instrumentation are discussed with respect to measurement of external neutron flux, core measurements, and reactor safety system. (H.B.G.)

6157 PROCESS COMPUTER ARRANGEMENTS AT THE KKS. Graf, G. (Kraftwerk Union AG, Erlangen, Ger.); Zimmermann, M. Atomwirt., Atomtech.; 16: No. 11, 599-600 (Nov 1971). (In German).

The process computer arrangement of the KKS essentially consists of two coupled central units of type 305 of the Siemens system 300. As conventional duty it keeps records of operation disturbances, switching, and measuring data. It also indicates disturbances visually. Its nuclear and thermodynamic programs contain power density distribution, burnup distribution, and distribution of cooling channel parameters. The printout yields, with respect to fuel elements, total distribution as well as mean and maximal values. Graphically displayed are cooling channel parameters for fuel elements with extreme thermal load. (tr-auth)

6158 THERMOTECHNICAL DESIGN OF THE KKS REACTOR. Frei, G.; Ulrych, G.; Winkler, F. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 592-6(Nov 1971). (In German).

Power capacity of fuel rods as well as power density distribution of the reactor at the nuclear power plant Stade permit a compact construction of the core with a mean power of 85.6 kW/dm^3 and a thermal power of 1900 MW. At maximal design values of hot channel factors and at a thermal power of 1.15 overload, the hot channel reaches a rod power density of 644 W/cm. Under these conditions, even the highest internal temperature remains safely below the melting temperature. The reactor safety system reliably prevents the exceeding of the maximal power limit at 115%. In addition, the safety system possesses a boiling limit that restrains the operational range irrespective of power. (H.B.G.)

6159 PHYSICAL ARRANGEMENT OF THE KKS. Boehm, W.; Katinger, T.; Kollmar, W. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 590-2(Nov 1971). (In German).

In the neutron physical arrangement of the reactor core for the nuclear power plant Stade, five conditions had to be met. The ratio of maximum local power density to the mean power density in the reactor core should at full power never exceed a given value. Mean burnup should be as close as possible to the economic optimum. Temperature coefficient of the cooling medium at full power should always be negative. In daily operation, the reactor should be able to handle swiftly power cycles of 100%–40%–100%. The control rod system should safely shut down the reactor in any operational situations. Briefly discussed are means by which the above listed conditions are met. (H.B.G.)

6160 NUCLEAR POWER PLANT STADE. Atomwirt., Atomtech.; 16: No. 11, 585-90(Nov 1971). (In German).

Important data of the Stade nuclear power plant are tabulated. Detailed information is listed under the following major headings: total assembly, reactor installation, neutron physical data, thermodynamic aspects, reactor core, core assembly, materials in the core, control mechanism, reactor pressure container, steam producer, primary cooling system, turbine generator, and electrotechnical arrangements. (H.B.G.)

6161 REACTOR CORE AND FUEL ELEMENTS OF THE NUCLEAR POWER PLANT STADE. Holzer, R.; Knoedler, D. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 11, 581-4(Nov 1971). (In German).

In comparison with the nuclear power plant Obrigheim, core and fuel elements of the nuclear power plant Stade show advanced development with respect to enhancement of absolute as well as specific power and burnup, increased operational safety, improved accident protection, easier fuel element exchange, easier access for inspection, and simplification of manufacturing and quality control. Briefly discussed are changes in core assembly, poisons, neutron sources, and fuel elements. (tr-auth)

6162 GENERAL LAYOUT OF THE NUCLEAR POWER PLANT STADE. Mueller, H. (Siemens AG, Erlangen, Ger.); Stahlschmidt, H. Atomwirt., Atomtech.; 16: No. 11, 579-81 (Nov 1971). (In German).

The 660 MW nuclear power plant Stade represents a logical further development of the 300 MW nuclear power plant Obrigheim. With its start of operation after a 4 year construction period, West Germany enters a phase of nuclear energy utilization through large installations. The plant contains a Siemens pressurized water reactor with four parallel, and equal, primary cooling circuits and with the appropriate support- and accessory installations. The safety concept is based on the fact that all parts under operational pressure are arranged in a full-pressure steel container with an external concrete cylinder. Electric current is produced by a 1500 rpm condensing turbine with directly coupled hydrogen-cooled three-phase current synchrogenerator. (tr-auth)

6163 BEZNAU NUCLEAR POWER PLANT: CONSTRUCTION, ORGANIZATION, AND IMPLEMENTATION. Owen, W. M.; Thee, W. B. (Westinghouse Electric Nuclear Energy Systems Europe, Brussels). Ind. At.; 15: No. 3, 41-51(Jul 1971). (In English and French).

The Beznau-1 nuclear power station is one of the few commercial nuclear power plants to have been built essentially on schedule. This is even more noteworthy considering the construction time was only four years. A description of the organization and implementation of the site work is given. Beznau-2, the adjacent nuclear power station, is now 90% completed and will become operational in 1972. The two stations will form Europe's first dual commercial nuclear power plant. (France)

6164 VANDELLOS NUCLEAR POWER PLANT. PROTECTION OF THE SEA WATER COOLING CIRCUITS. Kammerlocher, L. (Societe pour l'Industie Atomique, Paris). Energ. Nucl. (Paris); 13: No. 4, 265-74(Jul 1971). (In French).

The different ways in which the sea water intakes and the materials of the cooling circuits are protected against the various forms of sea water corrosion are discussed. The inner walls of the sea water tubes and basins must be protected against the multiplication, fixation, and local development of living microscopic organisms of plankton. These organisms are likely to be attracted by the higher temperature due to the outlets and are carried along by the pumping action. Protection of the refrigeration circuits involves stopping the solid debris (mechanical filters) and the coating of the inside of the tubes with a protective deposit (sulfation). (France)

6165 CONTROL OF THERMAL EFFECTS AT BEAVER VALLEY STATION. McAllister, Robert J. (Duquesne Light Co., Pittsburgh); Neale, Lawrence C.; Brodfeld, Bruno. J. Power Div., Amer. Soc. Civil Eng.; 96: No. PO3, 287-98(Jun 1970).

By combining a once-through condenser cooling water system with a supplemental cooling tower, the required temperature criteria can be met in the operation of Beaver Valley Station, even for the minimum river discharge. On the average, cooling tower assistance is necessary only two to three months each year, but not continuously. Extensive model and field studies have led to the selection of a plant outlet orientation which substantially affects the flow distribution in the two river channels and ensures rapid dilution of the heated effluent. No warm water recirculation is induced either through the back channel or around the island. (auth)

6166 POLITICS OF NUCLEAR POWER IN THE UNITED STATES. Wilson, Richard (Harvard Univ., Cambridge, Mass.). Nature (London); 233: No. 5320, 453-4(15 Oct 1971).

The issues surrounding nuclear power generation in the United States are critically examined and some of the misunderstandings are clarified. (auth) (UK)

6167 ON-LINE COMPUTER SYSTEM OF THE TSURUGA NUCLEAR POWER STATION. Nagayama, T. (Japan Atomic Power Co., Tokyo); Yamaguchi, K. Genshiryoku Kogyo; 17: No. 4, 35-40; 80(Apr 1971). (In Japanese).

An on-line computer system in BWR type nuclear power plants was developed to be installed as a part of plant equipment. The system in the Tsuruga Nuclear Power Station operates satisfactorily, though it required 19 months to perform site-debugging. Requirements for software functions are: (1) Continuous monitoring and alarm of plant conditions. (2) Pursuit of cause of plant failure. (3) Monitoring of control rod operation during start-up and shutdown. (4) Calculation and monitoring of core and plant performance. (5) Preparation of daily and monthly reports. Hardware includes computer unit GE/PAC 4020 (main), TIP system to measure neutron flux distribution by moving axially in-core ion chambers, RPI system to determine control rod position, RWM to monitor control rod operation, and assemblies including other analog and digital process I/O devices. Present status and progress up to normal operation are also briefly reported. (Japan)

6168 NUCLEAR POWER PLANTS FOR THE ELECTRICITY GENERATION IN THE FRG. Altvater, W.; Roehl, F. Gas-Wasserfach, Wasser-Abwasser; 112: No. 1, 1-10(1971). (In German).

The state of construction of nuclear power plants in the FRG is described. A general review on the hydroeconomy of a nuclear power plant is presented. (INIS)

6169 INTERPRETATION OF REACTIVITY AND POWER DISTRIBUTION MEASUREMENTS ON CAGR LATTICES. Ballard, P. J.; Bridge, M. J.; Young, J. D. (Berkeley Nuclear Labs., Eng.). J. Brit. Nucl. Energy Soc.; 10: No. 4, 287-98 (Oct 1971).

Reactivity and power distribution measurements on a number of uranium dioxide–graphite commercial advanced gas cooled reactor type lattices were compared with theory. The principal computer programs used in this work were the lattice data preparation codes WIMS and ARGOSY and the homogeneous and heterogeneous reactor codes CRAM and HET. The conclusions were that: ARGOSY systematically underestimated the reactivity as the weight of fuel in the cluster increased—only a part of this discrepancy could be associated with nuclear data; WIMS/HET predicted reactivities to within one and a half standard deviations and channel-to-channel power distributions to within ±2%—although the WIMS/CRAM were very mesh dependent the multi-mesh calculation agreed closely with WIMS/HET; discrepancies between measured and theoretical axial bucklings indicated that Benoist axial diffusion coefficients underestimated axial leakage by up to 10% and Monte Carlo calculations confirmed this discrepancy and showed that most of it was associated with the fast streaming in fuel clusters; and substantial discrepancies in cross channel power gradients led to the discovery that Benoist radial diffusion coefficients and the standard method for dipole boundary conditions had large systematic errors for these big pitch, heavily absorbing lattices which are typical of CAGR. (auth)

Operation and Economics

6170 (DOCKET-1151-48) ELK RIVER REACTOR, Interim Report on Status of Deactivated Reactor, August 1–November 1, 1971. (Rural Cooperative Power Association, Elk River, Minn.). 23 Nov 1971. 8p. Dep. NTIS.

6171 (DOCKET-1155-140) LA CROSSE BOILING WATER REACTOR, Incident Report No. DPC-71-17, Motor Control Center Control Power Transformer Fault. (Dairyland Power Coop-

erative, La Crosse, Wis.). 23 Nov 1971. 4p. (DPC-71-17). Dep. NTIS.

6172 (DOCKET-1155-141) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, September 1971. (Dairyland Power Cooperative, La Crosse, Wis.). 40p. (DPC-851-35). Dep. NTIS.

6173 (DOCKET-50003-94) INDIAN POINT STATION, UNIT NO. 1. Operations Report No. 19, Semiannual, April 1, 1971-September 30, 1971. (Consolidated Edison Co. of New York, Inc., New York). 30 Nov 1971. 58p. Dep. NTIS.

6174 (DOCKET-50029-160) YANKEE NUCLEAR POWER STATION. Operations Report No. 130, October 1971. (Yankee Atomic Electric Co., Westboro, Mass.). 19 Nov 1971. 9p. Dep. NTIS.

6175 (DOCKET-50213-119) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 71-10, October 1971. (Connecticut Yankee Atomic Power Co., Haddam). 24 Nov 1971. 12p. (NYO-3250-65). Dep. NTIS.

6176 (DOCKET-50255-57) PALISADES PLANT. Semiannual Report of Operations, June 30, 1971. (Consumers Power Co., Jackson, Mich.). 23 Nov 1971. 58p. Dep. NTIS.

6177 (DOCKET-50255-59) PALISADES PLANT. Cause and Correction of Damage to Control Rod Drive Mechanisms. (Consumers Power Co., Jackson, Mich.). 3 Dec 1971. 15p. Dep. NTIS.

6178 (DOCKET-50261-79) H. B. ROBINSON UNIT NO. 2. Operating Report No. 2, March 20, 1971-September 30, 1971. (Carolina Power and Light Co., Raleigh, N. C.). 24 Nov 1971. 171p. Dep. NTIS.

6179 STARTUP OF MIHAMA NUCLEAR POWER STATION. Fujii, Tetsuhiro (Kansai Electric Power Co. Inc., Osaka); Kato, Yasuji; Hatakeyama, Hideo; Tsukuda, Yoshiaki; Ohota, Kunihiro. Nippon Genshiryoku Gakkaishi; 13: No. 3, 147-59(Mar 1971). (In Japanese).

Start up tests of Mihama-I are described. Start up tests were performed from July 4 to November 20, 1970, on 32 specifications. Initial fuel loading test, criticality test, reactor physics test, power up test, and control and instrumentation equipment test are outlined. (Japan)

6180 NUCLEAR STEAM TURBINES. Okubo, Atsuo (Mitsubishi Heavy Industries, Ltd., Takasago, Japan). Mitsubishi Denki Giho; 45: No. 3, 348-55(Mar 1971). (In Japanese).

A 340 MW turbine, unit No. 1 of Mihama power station entered into commercial operation November, 1970. The design, construction features, test results, and test operation of the machines are described. (auth) (Japan)

6181 TEST OPERATION OF NO. 1 REACTOR PLANT IN THE FUKUSHIMA POWER STATION. Nomura, Akio (Tokyo Electric Power Co. Inc.). Karyoku Hatsuden; 22: No. 3, 223-7(Mar 1971). (In Japanese).

Construction of No. 1 reactor plant in the Fukushima Power Station was started in December 1966. Fuel was loaded into the reactor in July 1970. It is now in process of test operation. The operational tests carried out in 1970 are described. (Japan)

Safety and Siting

Refer also to abstracts 4704, 4712, and 4722.

6182 (BNWL-SA-3907) USE OF SIMULATION IN THE DEVELOPMENT OF REGIONAL PLANS FOR PLANT SITING AND THERMAL EFFLUENT MANAGEMENT. Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1971. Contract AT(45-1)-1830. 37p. (CONF-711112-4). Dep. NTIS.

From Annual meeting of American Society of Mechanical Engineers; Washington, D. C. (28 Nov 1971).

A dynamic planning method to study the technical and economic factors concerned with providing future energy supplies is described. The planning program consists principally of applying predictive technology, identifying and comparing management options, and developing evaluative procedures. Hierarchical simulation models are used to represent the properties of water bodies under consideration for use as a heat transfer medium. The COL HEAT model is described and used in simulation studies of the Ohio River Basin and Mississippi River Basin. (15 references) (H.D.R.)

6183 (DOCKET-50010-98) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications Proposed Change No. 17, Corrections to Supplement C. (Commonwealth Edison Co., Chicago, Ill.). 22 Nov 1971. 2p. Dep. NTIS.

Corrected information is presented concerning the control rod worth necessary to generate enough energy to displace the pressure vessel. (D.C.C.)

6184 (DOCKET-50237-207) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Additional Information Concerning Isolation of the Primary System on Reactor Vessel High Water Level. (Commonwealth Edison Co., Chicago, Ill.). 3 Dec 1971. 11p. (DOCKET-50249-111). Dep. NTIS.

6185 (DOCKET-50244-82) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Amendment No. 4 to Technical Supplement Accompanying Application to Increase Power. (Rochester Gas and Electric Corp., N. Y.). 29 Nov 1971. 17p. Dep. NTIS.

Additional information is presented concerning the performance of the emergency core cooling system for small break conditions. (D.C.C.)

6186 (DOCKET-50249-110) DRESDEN NUCLEAR POWER STATION, UNIT 3. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 22p. Dep. NTIS.

6187 (DOCKET-50255-58) PALISADES PLANT. Final Safety Analysis Report, Amendment No. 25. (Consumers Power Co., Jackson, Mich.). 23 Nov 1971. 194p. (CENPD-31). Dep. NTIS.

Performance evaluation of the emergency core cooling system under coolant loss accident conditions is presented. (D.C.C.)

6188 (DOCKET-50259-32) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 16. (Tennessee Valley Authority, Chattanooga). 29 Nov 1971. 214p. (DOCKET-50260-31; DOCKET-50296-30). Dep. NTIS.

Revised technical specifications and limiting conditions for operation are presented. Additional information concerning piping systems and instrumentation is included. (D.C.C.)

6189 (DOCKET-50261-78) H. B. ROBINSON UNIT NO. 2. Discussions and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 14p. Dep. NTIS.

6190 (DOCKET-50261-80) H. B. ROBINSON STEAM ELECTRIC PLANT UNIT NO. 2. Environmental Monitoring Report, April 1, 1971-September 30, 1971. (Carolina Power and Light Co., Raleigh, N. C.). 34p. Dep. NTIS.

6191 (DOCKET-50267-36) FORT ST. VRAIN NUCLEAR GENERATING STATION. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 22 Nov 1971. 16p. Dep. NTIS.

6192 (DOCKET-50270-36) OCONEE NUCLEAR STATION, UNITS 2 AND 3. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Nov 1971. 23p. (DOCKET-50287-33). Dep. NTIS.

6193 (DOCKET-50275-20) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 35p. (DOCKET-50323-18). Dep. NTIS.

6194 (DOCKET-50277-29) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment No. 12. (Philadelphia Electric Co., Pa.). 7 Dec 1971. 112p. (DOCKET-50278-29). Dep. NTIS.

Revised design parameters of the Peach Bottom Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

6195 (DOCKET-50280-54) SURRY POWER STATION, UNITS 1 AND 2. Discussions and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 Dec 1971. 15p. (DOCKET-50281-52). Dep. NTIS.

6196 (DOCKET-50280-55) SURRY POWER STATION, UNITS 1 AND 2. Environmental Report Supplement, Operating License Stage Volume 1. (Virginia Electric and Power Co., Richmond). 1 Dec 1971. 365p. (DOCKET-50281-53). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Hydrological and meteorological data for the reactor site are included. (D.C.C.)

6197 (DOCKET-50280-56) SURRY POWER STATION, UNITS 1 AND 2. Environmental Report Supplement Operating License Stage Volume 2. (Virginia Electric and Power Co., Richmond). 1 Dec 1971. 447p. (DOCKET-50281-54). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

6198 (DOCKET-50280-57) SURRY POWER STATION, UNIT NO. 1. Examination of Stainless Steel Weld Joints. (Battelle Columbus Labs., Ohio). 17 Aug 1971. 24p. Dep. NTIS.

6199 (DOCKET-50280-58) SURRY POWER STATION, UNITS 1 AND 2. Report No. SW-MER-1A, Supplement B. (Virginia Electric and Power Co., Richmond). 7 Dec 1971. 46p. (DOCKET-50281-55). Dep. NTIS.

Additional information is presented concerning the use of sensitized stainless steel in the piping systems of the Surry Power Reactor Units 1 and 2. (D.C.C.)

6200 (DOCKET-50282-45) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 16p. (DOCKET-50306-44). Dep. NTIS.

6201 (DOCKET-50286-40) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Nov 1971. 26p. Dep. NTIS.

6202 (DOCKET-50286-41) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Environmental Report, Supplement No. 1. (Consolidated Edison Co. of New York, Inc., New York). 8 Dec 1971. 79p. Dep. NTIS.

Additional information is presented concerning radioactive and thermal discharges from the reactor. The effects of reactor operations on the environment are analyzed. (D.C.C.)

6203 (DOCKET-50289-42) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Containment Building Ring Girder Construction and Repair. (Metropolitan Edison Co., Reading, Pa.). 3 Nov 1971. 73p. Dep. NTIS.

6204 (DOCKET-50293-62) PILGRIM NUCLEAR POWER STATION. Supplementary Information Regarding Control of Combustible Gas Concentrations. (Boston Edison Co., Mass.). 29 Nov 1971. 14p. Dep. NTIS.

6205 (DOCKET-50298-25) COOPER NUCLEAR STATION. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 21p. Dep. NTIS.

6206 (DOCKET-50302-30) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Nov 1971. 29p. Dep. NTIS.

6207 (DOCKET-50305-30) KEWAUNEE NUCLEAR POWER PLANT. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 15p. Dep. NTIS.

6208 (DOCKET-50309-44) MAINE YANKEE ATOMIC POWER STATION. Final Safety Analysis Report, Amendment No. 32. (Maine Yankee Atomic Power Co., Westboro, Mass.). 30 Nov 1971. 202p. Dep. NTIS.

Additional data on the design parameters and operations aspects of the reactor are presented. Performance evaluation of the emergency core cooling system is included. (D.C.C.)

6209 (DOCKET-50312-29) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. Division of Reactor Licensing (AEC), Washington, D. C.). 2 Dec 1971. 25p. Dep. NTIS.

6210 (DOCKET-50315-54) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Nov 1971. 18p. (DOCKET-50316-54). Dep. NTIS.

6211 (DOCKET-50317-31) CALVERT CLIFFS NUCLEAR POWER PLANTS, UNITS 1 AND 2. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Jul 1969. 21p. (DOCKET-50318-31). Dep. NTIS.

6212 (DOCKET-50317-32) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 15. (Baltimore Gas and Electric Co., Md.). 26 Nov 1971. 337p. (DOCKET-50318-32). Dep. NTIS.

Revised design parameters of the Calvert Cliffs Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

6213 (DOCKET-50321-28) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Nov 1971. 24p. Dep. NTIS.

6214 (DOCKET-50331-31) DUANE ARNOLD ENERGY CENTER. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Nov 1971. 27p. Dep. NTIS.

6215 (DOCKET-50333-35) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Discussion and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 22p. Dep. NTIS.

6216 (DOCKET-50333-36) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Environmental Report, Operating License Stage, Supplement. (Power Authority of the State of New York). Nov 1971. 65p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

6217 (DOCKET-50354-18) NEWBOLD ISLAND NUCLEAR GENERATING STATION. Final Safety Analysis Report, Amendment 11. (Public Service Electric and Gas Co., Newark, N. J.). 30 Nov 1971. 316p. (DOCKET-50355-18). Dep. NTIS.

Performance evaluation of the emergency core cooling system is presented. Revised indices and table of contents for the PSAR are included. (D.C.C.)

6218 (DOCKET-50358-28) WM. H. ZIMMER NUCLEAR POWER STATION. Environmental Report, Amendment No. 2. (Cincinnati Gas and Electric Co., Ohio). 3 Dec 1971. 109p. Dep. NTIS.

Additional information is presented concerning radioactive and thermal discharges from the reactor. Meteorological data for the reactor site are included. (D.C.C.)

6219 (DOCKET-50358-29) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 21. (Cincinnati Gas and Electric Co., Ohio). 3 Dec 1971. 117p. Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the William H. Zimmer Power Reactor Unit 1. (D.C.C.)

6220 (DOCKET-50367-24) BAILLY GENERATING STATION, NUCLEAR I. Environmental Report, Amendment No. 1, Supplement No. 1. (Northern Indiana Public Service Co., Hammond). 23 Nov 1971. 356p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

6221 (DOCKET-50369-16) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Construction Permit State, Supplement 1. (Duke Power Co., Charlotte, N. C.). 24 Nov 1971. 155p. (DOCKET-50370-15). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

6222 (DOCKET-50373–12) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 6. (Commonwealth Edison Co., Chicago, Ill.). 3 Dec 1971. 184p. (DOCKET-50374–12). Dep. NTIS.

Revised design parameters of the La Salle County Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

6223 (DOCKET-50376–24) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Amendment No. 12. (Puerto Rico Water Resources Authority, San Juan). 15 Dec 1971. 155p. Dep. NTIS.

Revised design parameters of the Aguirre Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

6224 (DOCKET-50382–13) WATERFORD STEAM ELECTRIC STATION, UNIT NO. 3. Preliminary Safety Analysis Report, Amendment No. 7. (Louisiana Power and Light Co., New Orleans). 29 Nov 1971. 230p. Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

6225 (DOCKET-50387–13) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 4. (Pennsylvania Power and Light Co., Allentown). 7 Dec 1971. 127p. (DOCKET-50388–13). Dep. NTIS.

Revised design parameters of the Susquehanna Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

6226 (HEDL-SA–275) SOURCE TO RECEPTOR TRANSPORT OF NUCLEAR FACILITY EFFLUENT AND DOSE CALCULATIONS. Dotson, W. L. (Hanford Engineering Development Lab., Richland, Wash.). [nd]. Contract AT(45-1)-2170. 36p. (71-AP–11; CONF-711106–2). Dep. NTIS.

From Air pollution control meeting; Calgary, Alberta, Canada (22 Nov 1971).

Calculation of the radiological effects in the year 2000 due to nuclear facility operation requires the development of a number of computer models to characterize receptor characteristics, transport processes, and dose evaluation. The release patterns provide input to aerial and water transport computer programs. These programs calculate deposition and concentrations at points of interest throughout the region. Radiological doses for various organs of typical individuals are calculated at these points in the region. (9 references) (auth)

6227 QUALITY ASSURANCE FOR NUCLEAR POWER PLANTS. Noma, I. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 17: No. 4, 41-5(Apr 1971). (In Japanese).

The concept of quality assurance for nuclear machinery and equipment was introduced first in ASME Section III, while in Japan, relating laws were executed corresponding to construction permit and operating licenses in the U.S.A. The quality assurance for the machinery and equipment is carried out by the manufacturers, and reactor pressure vessels are produced according to the quality assurance program. As for the quality assurance for plants, the machinery and equipment are included in addition to purchase management, installation on site, and trial operation. Quality assurance is based on fundamental concepts of self regulation and self management. Organization and personal competence to execute the quality assurance function should be made clear in documents. In order to confirm adequacy of the self management, it is required to make inspections according to the predetermined program. (Japan)

6228 HOW SAFE ARE POWER PLANTS? Stauber, E. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 16: No. 11, 570-3(Nov 1971). (In German).

As of May 1971, in West Germany seven nuclear power plants with 906 MW(e) were operational and thirteen with 9760 MW(e) were under construction or in the planning stage. Evaluation of operation experience over several years shows that the environmental burden lies below 1% of natural background radiation. Discussed are public relations and risk, environmental hazards, and design and construction principles. 11 references. (H.B.G.)

6229 NUCLEAR POWER PLANT STADE (KKS). Pahlke, G. (Nordwestdeutsche Kraftwerke AG, Hamburg). Atomwirt., Atomtech.; 16: No. 11, 578(Nov 1971). (In German).

After four years of construction, the 662 MW nuclear power plant Stade will be completed in April 1972. It is one of two nuclear power plants that were commissioned by private industry in West Germany. The plant contains a pressurized water reactor and represents the largest of its type on the continent. Cost of produced electricity is significantly lower than that of conventional power plants. Briefly discussed are site, cooling water, and connection to the general power grid. (H.B.G.)

Power Reactor Development

Refer also to abstracts 4427, 4449, 4493, 6344, and 6353.

6230 (ANL–7872) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, OCTOBER 1971. (Argonne National Lab., Ill.). 23 Nov 1971. Contract W-31-109-eng-38. 179p. Dep. NTIS.

Highlights of project activities for October 1971 are summarized. The EBR-2 operations, fuels and materials studies, and testing activities are reported. Heat transfer and fluid flow studies for LMFBR safety aspects are reviewed. Development of LMFBR instrumentation is described. Analysis of sodium impurities and corrosive properties is presented. Performance characteristics of stainless steel clad plutonium oxide (PuO_2) – uranium oxide (UO_2) fuel rods are described. Reprocessing methods for LMFBR fuels are discussed. Reactivity measurements for ZPR-6 and ZPPR-2 assemblies are presented. Control rod worth measurements for ZPR-9 and ZPR-6 assemblies are included. LMFBR safety studies are described. (D.C.C.)

6231 (BC-TOP–8) TENDON END ANCHOR REINFORCEMENT TEST. (Bechtel Corp., San Francisco, Calif.). Nov 1971. 103p.

In order to provide data from which refinements may be made in the design of reinforcement needed to resist the forces delivered by large post-tensioning tendons to concrete end blocks, a testing program was devised. The program involved the construction, instrumentation, and testing of two large blocks of concrete reinforced to resist the bursting stresses resulting from the very large forces which are delivered by the bearing plates of post-tensioning tendons such as are employed in prestressing secondary containment vessels of nuclear power plants. Loads which were intended to simulate the post-tensioning tendon forces were applied to the blocks. The test specimens and procedures are described and test results are presented. (H.D.R.)

6232 (GULF-GA-A–10754) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1971. (Gulf General Atomic Co., San Diego, Calif.). 30 Jul 1971. Contract AT(04-3)-633. 59p. Dep. NTIS.

The research and development program for the Public Service Company of Colorado 330-MW(e) High-temperature Gas-cooled Reactor is reviewed. Studies of component development, such as auxiliary equipment and special tools, and nuclear analysis of the fuel cycle, fuel zoning, and power shaping are included. The fuel development program includes demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures. Studies covering the components of the steam generator under operating conditions are summarized. Experimental procedures and results are discussed and, where appropriate, the data are presented in tables, graphs, and photographs. More detailed descriptions of experimental work are presented in topical reports, and these are listed at the end of the report. (auth)

6233 (GULF-GA-A–10850) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1971. (Gulf General Atomic Co., San Diego, Calif.). 29 Oct 1971. 36p. Dep. NTIS.

The research and development program for the Public Service Company of Colorado 330-MW(e) High-temperature Gas-cooled Reactor is reviewed. Studies of component development, such as auxiliary equipment and special tools, and nuclear analysis of the fuel cycle, fuel zoning, and power shaping are included. The fuel development and fuel element proof testing programs include demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel. Studies covering the

components of the steam generator under operating conditions are summarized. Experimental procedures and results are discussed and, where appropriate, the data are presented in tables, graphs, and photographs. More detailed descriptions of experimental work are presented in topical reports, and these are listed at the end of the report. (auth)

6234 (ORNL-TM-3595) INDEXED ABSTRACTS OF SELECTED REFERENCES ON MOLTEN-SALT REACTOR TECHNOLOGY. Cardwell, D. W.; Haubenreich, P. N. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 213p. Dep. NTIS.

Abstracts are given for 321 reports and articles which provide an introduction to MSR technology and describe major developments since 1960. Three indexes are provided: by keyword, by author, and by subject category. (auth)

6235 (RT/FI-(70)51) POWER DISTRIBUTIONS AND REACTIVITY WORTHS FOR DIFFERENT PATTERNS IN A UO_2–PuO_2 MICROLATTICE. PART II. Orestano, F.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1970. 57p. Dep. NTIS (U. S. Sales Only).

Additional lattice patterns designed to answer specific questions concerning power reactor operation are presented. Five group calculations for the most significant patterns are included. The spectral indexes in the uniform lattice and in the presence of inhomogeneities are described. The results of a detailed evaluation of the reaction rates inside the cell are presented. The evaluation of effects due to various modifications in nuclear libraries and in the geometrical description of the system is analyzed. The evaluation of the absorption rate of Pu-239 is discussed. 15 references. (auth)

6236 NUCLEAR REACTOR MOTOR. Moore, Richard L. British Patent 1,249,430. 13 Oct 1971. Filed 15 Sep 1970.

Reference is made to reciprocating type motors directly driven by nuclear reactor power. In the system described nuclear fuel and liquid moderator are sealed in a chamber of variable volume, a mechanical work performing means is reciprocatably mounted in association with the chamber, and connected thereto. The moderator is vaporized by nuclear heat so as to generate pressure and a natural resonance is set up in the work performing means so as to modulate its reactivity to a desired frequency, thus automatically controlling cyclical generation of nuclear energy. Control rods are provided and are movable relative to the fuel and moderator to a selected position, commensurate with the work to be performed, for initiating production of nuclear energy and for course control of the energy released after initiation. This automatically controls the cyclical generation of nuclear energy by cyclically changing the volume of the chamber in response to movement of the work performing means. The nuclear fuel may be in solution in the moderator, and the moderator may be water. (UK)

6237 FLUID-COOLED NUCLEAR REACTORS. Walker, Alexander; Williams, Michael Roger Lloyd (to British Nuclear Design and Construction Ltd.). British Patent 1,249,306. 13 Oct 1971. Filed 8 Apr 1968.

In the reactor described the core is in the form of parallel columns, each column being located in the core by a pair of support members with clearances between the columns to allow for any bowing that might occur under irradiation. One of the support members of each column is releasable so that the column is left free to be removed from the core, and replaced, via a standpipe extending through the pressure vessel wall. Preferably the upper support members are releasable from their columns and are arranged in groups, each group being carried by a common link member, so that a group of columns may be released in a single operation. The common link member may comprise a standpipe closure member. (UK)

6238 STANDARD FOR ADMINISTRATIVE CONTROLS FOR NUCLEAR POWER PLANTS. Draft No. 6. ANS-3.2 1971. Hinsdale, Ill.; American Nuclear Society (1971). 41p.

Criteria for administrative controls necessary for the safe and efficient operation of nuclear power plants are presented. Test, mobile, and experimental reactors, as well as reactors not subject to AEC licensing, are excluded because of differences in operational practices and contractural requirements. (auth)

6239 NUCLEAR REACTORS. Paget, Francis Thomas William; Hinton, Brian (to United Kingdom Atomic Energy Authority). British Patent 1,250,617. 20 Oct 1971. Filed 28 Jun 1968.

Reference is made to reactors having liquid moderators and reflectors, and operating on the soluble poison system. The reactor system described employs a separative barrier between an inner moderating zone containing the nuclear fuel and an outer reflecting zone surrounding the inner zone. The moderator material in the inner zone contains a variable quantity of soluble poison, but the outer zone moderator is poison-free, and because the nuclear properties of the unpoisoned reflector do not vary during the fuel cycle, improved power form factors are achieved. The system is particularly applicable to heavy water moderated reactors employing a calandria for the moderator; the separative barrier then extends between the end walls of the calandria. The calandria should preferably be of a shape that takes cognizance of the fact that neutron flux density diminishes axially from the center of the reactor core, so that the reflector may decrease in radial thickness towards the end of the calandria thereby reducing the total amount of explosive moderating liquid in the calandria. A suitable shape is barrel shape, and the calandria vessel may comprise a group of interconnected tanks. The liquid in the outer zone may be cooled by circulation through heat exchange means separate from that used for the inner zone liquid. Alternatively, a purge gas may be injected into the outer zone to turbulate the reflector liquid thereby enhancing heat transfer from the reflector to the moderator to avoid the need for circulating means for the reflector. (UK)

6240 RECENT PROBLEMS ON ATOMIC POWER. Ipponmatsu, Tamaki (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 4, 209-17(Apr 1971). (In Japanese).

The conditions of the development of atomic power generation are examined. Policies to be taken and aspects of the problems in atomic power generation are discussed. The problems on atomic power generation include: (1) problems in the course of construction and operation of already verified reactors, i.e., magnox-type reactors, PWRs and BWRs; (2) fuel cycle problems from the standpoint of management of uranium resources and enrichment of uranium; (3) the problems of waste disposal and associated environmental problems; (4) the problems which may arise in the course of development of such advanced type reactors as ATRs, HTRs and FBRs. (Japan)

6241 REACTOR TECHNOLOGY. VOLUME 14, NUMBER 4. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (Winter 1971-1972). 54p. GPO $0.75.

Separate abstracts are presented for 4 articles concerning creep measurements in reactor fuels and structural materials, tritium production and distribution in molten-salt reactors, reactivity meters for liquid metal-cooled fast reactors, and reactor noise monitoring equipment. (D.C.C.)

For abstracts of individual papers see: 6242, 6291, 6292, and 6395.

6242 TECHNOLOGY OF IN-PILE CREEP MEASUREMENTS. Cybulskis, Peter (Battelle Memorial Inst., Columbus, Ohio). Reactor Technol.; 14: No. 4, 315-34(Winter 1971-1972).

The possible effects of radiation-induced creep on the long-term performance of fuel and structural materials have been a source of continuing concern in the development of power reactors. Owing to the extremely severe thermal and radiation environments to be encountered, radiation-induced creep is of particular concern in the design of liquid-metal-cooled fast breeder reactors (LMFBRs). However, this concern is by no means limited to LMFBRs. A number of experimental programs have been undertaken to investigate the nature of the enhanced plasticity observed to take place in reactor environments. These programs encompass ceramic fuel as well as metallic cladding and structural materials under a variety of conditions. The experimental phases of the various programs are reviewed, with particular emphasis on the technology of specimen and capsule design, method of specimen loading, environmental control, and nature and precision of experimental measurements. Representative results are shown, as appropriate, to indicate the degree of success that each approach has achieved. 30 references. (auth)

6243 VOPROSY KONSTRUIROVANIYA YADERNYKH REAKTOROV. (Problems of Construction of Nuclear Reactors). Kramerov, A. Ya. Moscow; Atomizdat (1971). 328p.

Specific features of various types of nuclear reactors are compared: liquid fuel, fast neutron, water-cooled, and those moderated by graphite and heavy water. Fuel elements, fuel casettes, operating controls, servomechanisms, and shielding are important topics. A number of chapters focus attention on the reactor vessel, reactor core, methods of loading, and canal construction, respectively. (K.S.W.)

6244 FAST BREEDER REACTOR. Mueller, A. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,539,989. 16 Oct 1969. Filed 25 Mar 1966. (In German).

A fast breeder reactor with fuels elements preferably in the form of rods is described. It is cooled by a circulating coolant, preferably steam. The ratio of the quantity dk/ds of the coolant to the fuel in the direction of coolant flow measured over the length of the fission zone is almost constant. (tr-auth)

6245 PREDICTION OF FAILURE RATES AND FAILURE MODES OF MECHANICAL AND ELECTRICAL EQUIPMENT COMPONENTS BY THE FAULT TREE METHOD AND FAILURE EFFECT ANALYSIS. Balfanz, H.-P. (Technische Ueberwachungsvereine eV, Cologne). Kerntech. Atomprax.; 13: No. 9, 392-9(Sep 1971). (In German and English).

A method for calculating and predicting, with the aid of the fault tree method and of failure effect analysis, the failure rates and failure modes of components from the failure performance of their individual component parts is described. In failure effect analysis, all the individual parts of a component are studied in respect of all physically possible failure modes, and the effects of these failures on the component as a whole are determined. The fault tree method links together logically all the failure modes of all the individual parts, and is a mathematical model for calculating the failure performance of the component as a whole. Comparisons are presented between calculated failure rates and published failure rate data for a Barton cell, a pneumatic switch, a load break switch, a check valve and a single-stage centrifugal pump. Load factors, used as weighting factors representing the effects of service and stress conditions on failure rates, are outlined. 24 references. (auth)

Kinetics and Dynamics

Refer also to abstract 6325.

6246 (AECL-3857) LATREP USER'S MANUAL. Phillips, G. J.; Griffiths, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 343p. (CRNL-543). Dep. NTIS (U. S. Sales Only). AECL $7.00.

LATREP is a FORTRAN 4 code for the CDC 6600 computer. The code may be used to calculate lattice parameters for heavy water moderated reactor cells containing either annular or cluster fuel elements. The fuel may be in the form of full length rods or short bundles. The code is limited to four fuel materials: uranium metal, uranium dioxide, uranium carbide and thorium dioxide. Coolant may be light or heavy water, air, or organic fluids. The code uses multiregion collision probability theory and a one group thermal cross section convention. A burnup calculation is included, which considers eleven heavy elements, three high cross section fission products, and three pseudo fission products. 38 references. (auth)

6247 (EIR-199) NUCLEAR DESIGN CODES ADGAUGE AND STOER. Haschke, D.; Nyffenegger, U. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). May 1971. 57p. Dep. NTIS (U. S. Sales Only).

The code package ADGAUGE-STOER has been developed to calculate the reactivity effects of small perturbations in a reactor. The codes are based on perturbation theory combined with diffusion theory fluxes. The code ADGAUGE computes the multigroup fluxes and adjoint fluxes, which are subsequently used by the STOER code, which computes the reactivity coefficients as derived by first-order perturbation theory. The code package is in regular production use for gas cooled fast reactor calculations. The application of the code family is not restricted to a specific class of reactor, but the present version is only capable of treating problems with down-scattering due to limitations in the ADGAUGE-part of the program package. Programming of the codes has been done in FORTRAN-IV for a CDC 6400/6500 computer operating under the SCOPE 3.2.0 monitoring system. Both codes are completely core-contained. The transfer of information from ADGAUGE to STOER goes via disk file or magnetic tape file. (6 references) (auth)

6248 (JAERI-1214) ANALYSIS OF PROMPT MODERATOR HEATING REACTIVITY FEEDBACK EFFECT. Ishikawa, Michio (Japan Atomic Energy Research Inst., Tokyo). 20 Jan 1971. 41p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

The SPERT-III E-Core transient test has demonstrated that the prompt moderator heating (PMH) effect is a significant reactivity feedback contributor in the rapid excursion power in some reactor conditions. The PMH effect is theoretically confirmed and the complex factors which govern the transient behavior are investigated in detail, such as coolant temperature and velocity, initial power level, power profile in the core, and reactivity insertion rate. Several assumptions are made in the theory of PMH effect in order to have a simple characteristic equation. The newly-developed nuclear thermal hydrodynamic kinetics code EUREKA is used for the quantative analysis of the PMH effect, of which the results agree well with the SPERT-III E-Core test data. 16 references. (auth)

6249 (RT/FI-(71)9) CROSS SECTION LIBRARIES SETUP FOR BURNUP CALCULATIONS IN THE PRESENCE OF Gd AS A BURNABLE POISON IN LWR'S. Iorio, G.; Pistella, F.; Sisto, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 41p. Dep. NTIS (U. S. Sales Only).

A cross section library has been set-up to be used for burnup calculations in the presence of Gd. The available cross section data are briefly discussed, a new reduced energy scheme is suggested and its validity is tested, the values resulted for the materials of interest are also given. A few assumptions are discussed which allow a simplified model to be used in burnup calculations. 12 references. (auth)

6250 MEASUREMENTS OF MULTIPLE CONTROL RODS EFFECT IN GRAPHITE MODERATED REACTORS. Kaneko, Yoshihiko; Akino, Fujiyoshi; Kitadate, Kenji; Kurokawa, Ryosuke (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 569-87(Oct 1971).

Measurements on the effects of multiple control rods arranged in ring geometry were undertaken with application of the pulsed neutron technique in SHE, a heavily reflected graphite-moderated 20% enriched uranium critical assembly. The aggregate number of experimental cases exceeded 100, which systematically covered the four fundamental factors to determine the control rod effects: (1) The atomic ratio of ^{235}U to C in the core region ($C/^{235}U$ = 2,226 and 5,378), (2) The neutron absorbing substances in the control rods and their densities (B_4C powder and Cd plate. Density of B_4C: 0.1 and 1.0 g/cm^3), (3) Geometrical factors of the control rods (Cylindrical shape, 20 or 44 mm in diameter), (4) Number of control rods (One to six control rods inserted in circular geometry). The experimental results are compared with calculations based essentially on a system of simple two group Nordheim-Scalettar method used as tool to solve the three-dimensional diffusion equation. Agreement within about 10% was obtained between measurement and calculation utilizing extrapolation distances for the fast neutron group, determined semi-experimentally. 21 references. (auth)

6251 SUBCRITICALITY MEASUREMENT IN AN LMFBR. Ackermann, Norbert J. Jr. Nucl. Safety; 12: No. 6, 583-90 (Nov-Dec 1971).

Reliable knowledge of the subcriticality state of a nuclear reactor at all times during shutdown, coupled with proper administrative control, should preclude the possibility of that reactor accidentally becoming critical or supercritical. The state of the art review of subcriticality measurement in the LMFBR gives particular attention to four measurement techniques: neutron-source multiplication, neutron-noise analysis, inverse kinetics, and pulsed neutrons. It is concluded that the neutron-source multiplication technique is the only method applicable for measuring the subcriticality in an LMFBR over the full range of shutdown. Present subcriticality-measurement development programs are reviewed, and future applications are discussed. 34 references. (auth)

Control Systems

6252 COMPUTER APPLICATION TO NUCLEAR POWER PLANTS. Watanabe, Satoshi; Odahashi, Shoju (Mitsubishi Electric Corp., Tokyo). Mitsubishi Denki Giho; 45: No. 3, 379-84(Mar 1971). (In Japanese).

Computer introduction in thermal power plants is divided into four steps: data logger; sequence monitor; automatic startup and shutdown; and optimizing control. Similar situation applies to nuclear power plants. An example of Mihama power plant is given as computer application to a pressurized water reactor plant. The computer used is Westinghouse PRODAC-250. Its functions are ordinary data processing, monitoring of reactor control and protecting devices, monitoring and calculation of reactor steam generating system, analysis of in-core thermocouple data, analysis of data of in-core neutron flux measuring system, calculation for following load change, performance calculation of secondary system, and process input monitoring. In the near future, operation of nuclear power plants will reach the stage controlled with computers. The control objects seem to be the following: startup and shutdown control, load control, fuel administration control, and emergency treatment and operation at the time of failure. (Japan)

6253 OPERATION OF NUCLEAR POWER PLANTS BY PROCESS COMPUTERS. Saito, Tsuyoshi (Tokyo Electric Power Co. Inc.). Haikan Gijutsu; 13: No. 4, 112-22(Apr 1971). (In Japanese).

Computer application to nuclear reactors seems to be developed through three stages from data processing to direct computer control. Final goal of the computer control is on-line complete automation of operation. In the computer system used at Fukushima Power Plant, a computer is used to provide results of detailed performance calculations and to perform data logging functions. The main purpose is to monitor and calculate power distribution of the core faster and more accurately with reading local neutron monitors. Capacity of this computer was determined so that various performance calculations, data collection, data analysis, and data processing are possible. Experiences in a few reactors in foreign countries are cited to see how computers should be adapted to fast breeder reactors. (Japan)

6254 POSITION INDICATOR FOR CONTROL ELEMENTS OF NUCLEAR REACTORS. Schallopp, Bernhard. German Patent 1,514,728. 2 Oct 1969. Filed 6 Jun 1961. (In German).

A control element, especially with hydraulic or pneumatic linear drive, for a nuclear reactor is described. By introduction of grooves it serves as the mobile part of a linear inductive stationary position indicator. (tr-auth)

6255 INSTALLATION, INSPECTION, AND TESTING REQUIREMENTS FOR INSTRUMENTATION AND ELECTRIC EQUIPMENT DURING THE CONSTRUCTION OF NUCLEAR POWER GENERATING STATIONS. IEEE Std 336 1971. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 16p.

The requirements for installation, inspection, and testing of Class I and Class IE electric power, instrumentation, and control equipment and systems during the construction phase of a nuclear power generating station are described. These requirements are intended to assure that only materials and equipment of acceptable quality are incorporated into the plant, that quality is maintained and quality workmanship prevails throughout the construction process, and that completed installations conform to specified requirements, so as to promote public safety, prevent accidents and mitigate the consequences of accidents if they occur, and provide a high degree of plant reliability. (auth)

Shielding

6256 (RCN-153) DINE: A ONE-DIMENSIONAL NEUTRON SHIELDING PROGRAM WITH PHYSICALLY DETERMINED SPACE MESH DISTANCES AND LINEAR ANISOTROPIC SCATTERING. Verschuur, K. A. (Reactor Centrum Nederland, Petten). Jun 1971. 29p. Dep. NTIS (U. S. Sales Only).

The ALGOL-program DINE is a multigroup removal diffusion program which calculates the neutron flux-and dose rate distribution in a reactor shield with multiregion slab geometry due to a cylindrical reactor core. From the integral transport equation for linear anisotropic scattering a different equation has been derived in which the mesh distance is proportional to the mean free path. This method gives an improvement of the deep penetration of diffusing neutrons. The program can be used in combination with the Monte Carlo program RAGA, which calculates the transport of the capture gamma rays in the shield using exponential transformation. The program is in operation on a 48K Philips Electrologica X8 computer. The calculation time for a reactor shield with a thickness of the order of 250 cm is about 5 minutes. 6 references. (auth)

Cooling Systems

Refer also to abstracts 4264, 4265, and 4267.

6257 (CONF-710335-1) REPORT OF THE SPECIALISTS' MEETING ON "OPERATIONAL SAFETY OF SODIUM CIRCUITS" HELD AT RISLEY, UNITED KINGDOM, MARCH 17-19, 1971. Eickhoff, K. G. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). [1971]. 9p. Dep. NTIS (U. S. Sales Only).

From International Working Group on Fast Reactors; Risley, England(17 Mar 1971).

Practices appropriate to Experimental Sodium Rigs and those appropriate to the Sodium Circuits of Reactors are compared. Experimental Rigs are frequently highly instrumented and operated for relatively short periods under the close attention of professional staff; reactor circuits must operate reliably for long periods (~30 years) with much less professional attention. The emphasis of the discussion was on the design, construction and operation of Experimental Sodium Rigs, although attention was paid to some particular aspects of reactor circuits. (auth)

6258 (ORNL-TM-2952) PARAMETRIC SURVEY OF THE EFFECTS OF MAJOR PARAMETERS ON THE DESIGN OF FUEL-TO-INERT-SALT HEAT EXCHANGERS FOR THE MSBR. Fraas, A. P.; LaVerne, M. E. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 53p. Dep. NTIS.

The design of heat exchangers for molten salt reactors involves so many parameters and their interrelationships are so complex that it is difficult to envision the effects of the various trade-offs that can be made in attempts to optimize the system. A procedure for carrying out such analyses is presented together with the results of a parametric study showing the effects of tube diameter, fuel pressure drop, inert salt pressure drop, and the temperature difference between the fuel and the inert salt with either $NaBF_4$ or Flinak as the fluid in the intermediate heat transport system. An unusual design for a 2200 MW(t), 100 MW(e) power plant was used as the reference design for the detailed calculations of the parametric study. (20 references) (auth)

6259 (ZJE-112) DEVELOPMENT OF MATERIALS AND TECHNOLOGIES FOR PWR-TYPE PRESSURE VESSELS. Becka, J.; Brumovsky, M.; Indra, J.; Stepanek, S. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 20p. (CONF-701214-15). Dep. NTIS (U. S. Sales Only).

From Conference on nuclear power; Piestany, Czechoslovakia (1 Dec 1970).

The development of PWR type reactor steel pressure vessels is discussed. The differences between American and Soviet conceptions from the point of view of design, materials and technology are described. The basic conditions for production of these vessels in the USSR are analyzed. Pressure vessel construction on site is chosen as a very advantageous way for manufacture of large power units in the near future. Basic mechanical properties, chemical content and degree of radiation embrittlement are shown for the most used types of steels which are also used and developed in the USSR. 20 references. (auth)

6260 IMPROVEMENTS IN AND RELATING TO AN ELECTROMAGNETIC DEVICE FOR FLOWRATE MEASUREMENT. Deslisle, Jean-Paul; Lacroix, Andre; Lions, Noel (to Commissariat a l'Energie Atomique). British Patent 1,251,872. 3 Nov 1971. Priority date 23 Jul 1968, France.

FLOWMETERS—design characteristics of electromagnetic, for liquid sodium cooled reactors

REACTORS, LIQUID METAL-COOLED—flowmeter for liquid sodium cooled, design characteristics of electromagnetic (D.L.C.)

6261 EXPERIMENTAL STUDY OF ACCURACY OF LEAK RATE TEST FOR REACTOR CONTAINMENT VESSEL. LEAK RATE TEST BY ABSOLUTE TEMPERATURE-PRESSURE METHOD. Yamaguchi, Tomio; Fukue, Hisayoshi; Hori, Yutaka (Kobe Technical Inst., Japan). Tech. Rev., Mitsubishi Heavy Ind.; 8: No. 1, 10-21(Feb 1971).

There are two methods of leak rate testing for reactor containment vessel of nuclear power plant: the absolute temperature-pressure method and the reference system method. The absolute temperature-pressure method is simpler and more practical than the reference system method in procedure and equipment used. Leak rate test on a model of a reduced scale of $\frac{1}{10}$ of Mihama No. 1 reactor containment vessel was conducted by this method. The results of the measurement were compared with calculated leak rate in order to know the accuracy of the method. The result of measurement was applied to the result of leak rate test carried out at the time of completion of Mihama No. 1 reactor containment vessel and it was confirmed that this method can be used with sufficient accuracy for leak rate test. (auth) (Japan)

6262 STUDY ON STRENGTH OF REACTOR PRESSURE VESSELS. Hayashi, Tsutomu (Hitachi Ltd., Ibaraki, Japan). Karyoku Hatsuden; 22: No. 3, 251-6(Mar 1971). (In Japanese).

Stress analysis methods for reactor pressure vessels and practical cases of the analysis based on ASME Code, Section III, are introduced. In Section III, stress is divided into primary stress, secondary stress and peak stress. With regard to each allowable stress, a stress estimation is made. In the stress estimation, there are two methods, experimental stress analysis and theoretical stress analysis. The latter one is a main method. There are three methods for the theoretical analysis, conventional method, difference method, and finite element method. In flanges in which largest stresses may occur, strict stress analysis and

displacement analysis must be made. At the same time, actually measured temperature distribution must be compared with the analytical one. Bolts need strict fatigue analysis. Stress analysis for nozzles is not yet perfect. But with area reinforcement, satisfactory nozzles can be designed. Concerning control rod housings, stubs, etc., with considerably high stress, careful design and analysis are needed. Concerning joints of supporting skirts and vessels, satisfactory design of the lagging material form around the skirts is needed, because high stresses occur. An experimental estimation is made concerning fatigue analysis on parts of special shape, because of less data for the fatigue strength decreasing factor. But design fatigue curves in ASME Code, Section III, give a good estimation. (Japan)

6263 IN-SERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. Ando, Yoshio (Tokyo Univ.). Karyoku Hatsuden; 22: No. 3, 231-43(Mar 1971). (In Japanese).

Testing and inspection methods for pressurized parts of LWR nuclear power plants are discussed. Objects of the in-service inspection are primary coolant systems, auxiliary systems associated with the coolant systems, and emergency core cooling systems. The inspection methods involve visual inspection, surface inspection, and volume inspection. As new inspection methods, the acoustic emission method and the electric resistance probe method are described. Instances of the in-service inspection on pressure vessels for JPDR and Oskarshamn are cited. (Japan)

6264 GRAPHITE MODERATOR STRUCTURES FOR NUCLEAR REACTORS. Lind, Robert; Price, Norman (to United Kingdom Atomic Energy Authority). U. S. Patent 3,607,641. 21 Sep 1971. Priority date 28 Feb 1967, Great Britain.

A graphite-moderated nuclear reactor with a reentrant core is provided with means for inducing coolant flowing through the moderator to diffuse into the moderator. The means may comprise flow restrictors in the coolant flow path whereby a pressure drop is created across individual graphite bricks forming the moderator and gas seals between the bricks. To facilitate sealing, engagement between bricks stacked in columns is in the peripheral region by recesses and separate keys pegged in position, leaving internal annular plane continuous surfaces in and between which a sealing ring is provided. (auth)

6265 NUCLEAR REACTOR ORIFICE-SEAL ARRANGEMENT. Hansen, Ned P.; Guenther, Ralph W. (to General Electric Co.). U. S. Patent 3,607,632. 21 Sep 1971. Filed 26 Nov 1968.

An orifice-seal arrangement, acting primarily as a coolant conduit, for nuclear reactors is disclosed. An orifice-seal consists of two coaxial telescoped tubes which are secured to a fuel assembly and to a wall of the coolant outlet plenum during reactor operation. The orifice-seal is adapted in conduct coolant from individual nuclear fuel assemblies to an outlet plenum while sealing against coolant leakage. In addition, the orifice-seal supports the individual fuel assemblies in a manner accommodating slight radial movement of fuel assemblies and thermal expansion within the assemblies during changes in reactor temperature. The orifice-seal also functions as an indicator of proper core assembly during fuel loading and reloading. (auth)

6266 TURBULENT-FLOW HEAT TRANSFER FOR IN-LINE FLOW THROUGH UNBAFFLED ROD BUNDLES: MOLECULAR CONDUCTION ONLY. Dwyer, O. E.; Berry, H. C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 46: No. 2, 284-303(Nov 1971).

The results of a theoretical study of molecular-conduction heat transfer to liquid metals flowing in-line through unbaffled rod bundles are reported. The flow is turbulent and fully developed, the heat transfer is fully developed, the bundles have equilateral triangular spacing, and there are no effects due to spacing devices. Circumferentially local heat transfer coefficients, rod-average heat transfer coefficients, and circumferential variation of wall temperatures have been obtained and correlated in terms of the various independent variables. The rods represent reactor fuel pins which consist of ceramic cores encased in metallic claddings. The following thermal boundary conditions were treated: (a) uniform wall heat flux in the axial direction and uniform wall temperature in the circumferential direction, on the outside surface of the cladding; (b) uniform wall heat flux in all directions on the outside surface of the cladding; and (c) uniform wall heat flux in all directions on the inside surface of the cladding. For boundary conditions (a) and (b), the independent variables are Reynolds number (Re) and rod spacing (P/D), while for boundary condition (c) there are two additional independent variables, i.e., relative cladding conductivity (k_w/k_f) and relative cladding thickness $[(r_2 - r_1)/r_2]$. The results, all expressed in the form of convenient dimensionless groups, are presented in tables and charts and in the form of simple mathematical expressions. 18 references. (auth)

6267 EXPERIMENTAL STUDIES ON RADIOACTIVE CONTAMINATION OF THE PRIMARY CIRCUITS OF REACTORS. Chantoin, P.; Dadillon, J.; Saroul, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 35-43(Apr 1971). (In French).

The contamination of the circuits of high temperature helium cooled reactors and sodium cooled fast reactors was studied. The release and deposition of fission products in the circuits of the Pegase reactor was studied by means of experiments on the irradiation loops. Experiments were carried out in a tank full of Na in which a sample of irradiated U had been melted. The Na–Ar interface corresponds to the highest level of contamination on the tank walls. In a tank containing circulating Na, the injection of a noble gas in the form of puffs led to a 100 percent recovery in Ar of the gas injected; on the other hand, when the flow is very small, the retention of Na is appreciable. Measurements were also carried out on the circuits of the Rapsodie reactor. (France)

6268 NUCLEAR REACTOR PRESSURE VESSEL STRUCTURE. Cahill, William Joseph Jr. (to Combustion Engineering Inc.). British Patent 1,252,943. 10 Nov 1971. Priority date 4 Dec 1967, United States.

PRESSURE VESSELS—design characteristics of dual concentric, for boiling and pressurized water reactors
REACTORS, BOILING—pressure vessels for, description of dual concentric
REACTORS, PRESSURIZED-WATER—pressure vessels for, description of dual concentric (D.L.C.)

6269 DEVICE FOR REMOVING FOREIGN MATTER FROM A CONTAINER OR THE LIKE. Maynard, George Herbert (to British Nuclear Design and Construction Ltd.). British Patent 1,250,002. 20 Oct 1971. Filed 5 Feb 1968.

The device described is used for the removal of foreign bodies from nuclear reactors. It consists of a pipe adapted to extend into and to closely approach the floor of the container with a skirt member to cover a major portion of the floor area of the container. A second pipe surrounds the first pipe and terminates just above the skirt member. The arrangement is such that a fluid flowing from the second pipe, across the upper surface of the skirt member, between the floor of the container and the lower surface of the skirt member and into the first pipe, causes loose matter deposited on the skirt member or floor to be drawn into the first pipe. The skirt member may comprise a flat disk or plate. (UK)

6270 NUCLEAR REACTOR. Schmidt, Karl-Rudolf; Oehlrich, Karl-Heinz (to Siemens AG). German Patent 1,439,073. 28 Aug 1969. Filed 26 Apr 1961. (In German).

A method for the production of relative forces, especially Coriolis force, in flows of liquids of different masses is described. The coolant of the reactor mixed with a granular or pulverized fissile material is used as the primary fluid. The fissile material is separated from the coolant at the reactor outlet. (tr-auth)

Fuels

Refer also to abstract 4996.

6271 (ANL-EBR-34) USER'S MANUAL FOR BEMOD-I, EBR-II Project. Ford, C. C.; Koenig, J. F. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Nov 1970. Contract W-31-109-eng-38. 119p. Dep. NTIS.

The BEMOD code was developed to model the behavior, and to estimate the lifetime of sodium-bonded fuel elements during irradiation. Since its inception, experimental results were collected and analyzed for the behavior of partially enriched uranium-5% fissium metallic fuel as well as depleted-uranium metallic fuel that was used as a radial blanket around the EBR-II Core. New fuel-swelling models were incorporated into the BEMOD code and new subroutines were added to BEMOD as technology has developed; thus BEMOD-I was developed. Modifications and additions to BEMOD are described. 9 references. (auth)

6272 (CEA-R-4210) NUCLEAR FUEL SIMULATION BY ELECTRICAL HEATERS. Teytu, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug 1971. 21p. (In French). Dep. NTIS (U. S. Sales Only).

The use of electric heaters as simulators in heat transfer experiments is described. The different heaters manufactured for this purpose by the heat transfer department of the Grenoble Nuclear Center are enumerated. The constructions and technical solutions adopted in their design are discussed. The fuel elements simulated were those of swimming pool reactors, water reactors

(boiling and pressurized), organic liquid cooled reactors, and fast reactors. (auth)

6273 (CEA-R-4234) COMPARISON OF MEASURED AND CALCULATED PLUTONIUM PRODUCTION IN THE CANADIAN NPD REACTOR. Duret, Maurice; Griffiths, J.; Bir, Roger; Chabrillac, Marcel; Vidal, Rene (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug 1971. 16p. (In French). Dep. NTIS (U. S. Sales Only).

The Canadian N.P.D. reactor is a heavy water cooled and moderated horizontal pressure tube reactor; it has operated at a power level of about 20 MW(e) since 1962. In 1968 a series of eight bundles with irradiations covering the range 1000 to 10,000 MWD/TEU were analyzed using mass spectrometry. Cross gamma-ray measurements were made on each pin to check burnup homogeneity, and so that representative pins could be selected. Uranium analysis was carried out with a UF_6 mass spectrometer, very accurate results being obtained in ^{235}U depletion measurements; a thermoionization device was used for plutonium analysis. The amounts of plutonium and neodymium were determined by the double dilution isotope method. Burnup values were determined from the $^{235}U/^{238}U$ ratios; other isotopic abundance ratios are compared to predictions made using both Canadian and French lattice methods. The results demonstrate an ability to predict the course of fuel burnup in CANDU-type reactors up to at least 10,000 MWD/TEU. (5 references) (auth)

6274 (NEDC-12198) PLUTONIUM UTILIZATION IN BOILING WATER REACTORS, PHASE II. Semiannual Report, July-December 1970. (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). May 1971. 39p.

For Edison Electric Inst., New York.

The development program for utilization of plutonium in boiling water reactors for the period July to December 1970 is reviewed. Big Rock Point reactor irradiation performance results are reported for 28 PuO_2-UO_2 fuel rods and three all PuO_2-UO_2 fuel rod bundles. Hot cell examination results to date are reported for four rods removed from Big Rock Point in February 1970 after one cycle of irradiation. Vermont Yankee design finalization and fuel fabrication for four recycle demonstration fuel bundles are reported and plans for pre-irradiation characterization and bundle assembly are described. Activities associated with the AEC-sponsored Integrated Safeguards Experiment and Plant Instrumentation Program are reported. The plutonium recycle design optimization and economic studies are summarized. The significant conclusions or observations of the program to date are that the test irradiations are proceeding without indication of failure problems; the interchangable plutonium recycle bundle design objective has been accomplished without compromise of important performance, economic, and safeguards criteria; and the annular fuel pellet concept continues to show promise as the most economical design for plutonium recycle in boiling water reactors. (auth)

6275 (RT/MET-(71)2) EXPERIMENTS ON FISSION PRODUCTS AND URANIUM RELEASE UP TO 1100°C FROM UO_2 IN SODIUM MEDIUM. Adami, M.; Segre, G. J.; De Vita, R.; Lepscky, C.; Suraci, F.; Tomassi, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 26p. Dep. NTIS (U. S. Sales Only).

The experiments carried out in order to investigate on the release phenomena from UO_2 in sodium for temperatures up to 1100°C and contact times up to 8.10^4 sec are described. Stainless steel capsules containing sodium and UO_2 pellets have been irradiated in the TRIGA MARK 1 reactor of the CSN Casaccia, and, subsequently, heated in induction furnace. The released fission product analysis has been then carried out by gamma spectroscopy; the released uranium analysis by fluorimetry. The results do not show a dependence on the contact time or temperature and they are, for every nuclide, release values in semistatic sodium and with low walls cooling. (26 references) (auth)

6276 (TID-25839) FUEL ROD DESIGN BASES. Anderson, C. A. Jr.; Markley, R. A.; Patterson, J. F. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1970]. Contract AT(30-1)-4200. 19p. Dep. NTIS.

Statistical techniques which may be used to account for both thermal and mechanical uncertainties in LMFBR fuel rod design limits are presented. A philosophy which may be used to arrive at both steady state and transient design limits is discussed. 6 references. (auth)

6277 FUELS CONTAINING GADOLINIA. Murota, Kazuo; Miyamoto, Toshiki (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu: 26: No. 8, 1019-23(Aug 1971). (In Japanese).

Almost all BWR's utilize initial and reload fuels containing gadolinia as the burnable poison. The reasons for using this kind of fuel, the nuclear and material characteristics of gadolinia, the design of the gadolinia-containing fuel, developmental research on the fuel, irradiation experiments, and the fabrication of the fuel are described. (auth) (Japan)

Auxiliary and Emergency Systems

Refer also to abstract 6255.

6278 (GEAP-13190) BWR STANDBY COOLING HEAT TRANSFER PERFORMANCE UNDER SIMULATED LOSS-OF-COOLANT CONDITIONS BETWEEN 15 AND 300 PSIA. Duncan, J. D.; Leonard, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1971. Contract AT(10-1)-1230; Subcontract S-7044. 220p. Dep. NTIS.

For Idaho Nuclear Corp., Idaho Falls.

Tests were conducted to determine the heat transfer effectiveness of the emergency cooling systems at pressures up to 300 psia. A full-scale, electrically heated, stainless steel-clad heater bundle was used to simulate a fuel bundle. Bottom flooding and top spray transient tests were performed under loss-of-coolant conditions. The thermal response of the cladding is reported. Individual local heat transfer coefficients were calculated as a function of location, time and the various test parameters. The variation of the coefficients provides insight into the heat transfer mechanisms significant during the emergency cooling phase of the postulated loss-of-coolant accident. Increasing the system pressure above atmospheric pressure improved the performance of both the bottom flooding and the top spray modes of emergency cooling. The time required for the cladding to cool to saturation temperature in the flooding mode and the maximum cladding temperatures in the spray mode were both significantly reduced as pressure was increased to 200 psia. 18 references. (auth)

6279 (ORNL-tr-2504) METHODS ADOPTED IN FRANCE FOR THE REMOVAL OF RADIOACTIVE IODIDES. Billard, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Proceedings of Containment and Siting of Nuclear Power Plants, Vienna, 3-7 April 1967. 23p. (CONF-670402-4). Dep. NTIS.

The efforts made to establish which of the various methods proposed for the removal of iodine and methyl iodide are suited to conditions in France are described. The results of a study on the trapping of methyl iodide with French-made activated carbons impregnated with potassium iodide or triethylene diamine are presented. The auxiliary equipment which should be incorporated in reactors and the methods of inspection adopted both for manufacture and for use of the equipment are described. (30 references) (auth)

6280 POWER-PULSE MONITORING PROBE. Boyd, Leo R. (to United States Atomic Energy Commission). U. S. Patent 3,597,612. 3 Aug 1971. Filed 27 Jan 1969.

An apparatus for monitoring total energy variations in a nuclear reactor comprises, in one embodiment, a heat sink, a mass of fissionable material in thermal contact with said heat sink and a thermocouple in electrical and thermal contact with said mass of fissionable material. In order to compensate for gamma radiation a further improvement is provided in another embodiment by adding a mass of material having the same gamma absorption characteristics as said mass of fissional material, said gamma absorbing material being electrically insulated from said heat sink, and a second thermocouple in electrical and thermal contact with said gamma absorbing material and in electrical series opposing connection with said first thermocouple. The disclosed device is used to measure the transient power variations and evaluate the Doppler effect for controlling reactor stability or to measure transient power variation in fast or thermal reactors to obtain data for monitoring the reactor operation. (Official Gazette)

6281 METHOD OF MEASURING BORON CONCENTRATION IN WATER BY NEUTRON ABSORPTION. Rajagopal, Venkatesan (to United States Atomic Energy Commission). U. S. Patent 3,597,613. 3 Aug 1971. Filed 19 Aug 1969.

A method and apparatus are described for determining boron concentration in water. The principle of neutron absorption is used with an electronic arrangement for determining the time required to count a predetermined number of nonabsorbed neutrons. The time to reach the same number of counts with no boron present is subtracted. The remaining time is found to

vary directly and linearly with boron concentration. (Official Gazette)

6282 ON-LOAD FUEL CHANGING EQUIPMENT OF NUCLEAR REACTORS. Yukishima, Itsuo (Fuji Electric Co. Ltd., Kawasaki, Japan). Karyoku Hatsuden; 22: No. 4, 406-13(Apr 1971). (In Japanese).

Fuel changing equipment for gas-cooled reactors developed in the U. K. is described. Results of trial manufacture and development work of the fuel changing equipment for a prototype Advanced Thermal Reactor are analyzed. (Japan)

6283 DEVELOPMENT ON THE REFUELLING MACHINE FOR PROTOTYPE ADVANCED THERMAL REACTOR. Yukishima, Itsuo (Fuji Electric Co. Ltd., Kawasaki, Japan). Fuji Jiho; 44: No. 4, 390-8(Apr 1971). (In Japanese).

A refuelling machine for ATR and its mock-up is described. The main characteristics of the refuelling mechanism are explained. Each part of the refuelling machine is described in detail, for instance snout, snout valve, reactor pressure vessel, internal mechanism, hydraulic driving mechanism, pressurized coolant system, running trucks, and control and measurement instruments. Furthermore, seal plugs, shielding plugs and fuel assemblies inserted into pressure tubes are described. Development test for the seal plugs, room temperature-high pressure test, loading test, high temperature test, irradiation test, and endurance test are described. Test conditions and results of connecting function test and leakage test for the snout are reported. Tests of six main parts are being carried out now. (Japan)

6284 POST-TENSIONED CONCRETE NUCLEAR STRUCTURES. Chauvin, Glen A.; Small, Robert J.; Walser, Adolf (Sargent and Lundy, Engineers, Chicago). J. Power Div., Amer. Soc. Civil Eng.; 96: No. PO3, 401-14(Jun 1970).

Post-tensioned concrete, because of the use of materials for the stresses that they are best suited for, offers many advantages for [illegible]nment structures. Economics plays a major role in the ev[illegible]n of any structure and the engineer must always make an ev[illegible]n study before a decision is made as to what type of structu[illegible]uld be constructed. Design characteristics of present conc[illegible]ontainment structures are described. (auth)

6285 DESIGN OF BROWNS FERRY CHIMNEY. Smith, John W.; Jonsson, Asgeir (Tennessee Valley Authority, Knoxville). J. Power Div., Amer. Soc. Civil Eng.; 96: No. PO3, 437-47(Jun 1970).

The Browns Ferry chimney will be far more slender than chimneys usually are because of the minimal gas volume and a desire for a pleasing architectural appearance. The chimney is designed for extremely severe forces, partly due to its proximity to important structures. The need to ensure that a catastrophic wind force could not break the chimney near its base and fell it into nearby structures resulted in designing into it a weaker section in its upper portion. An ultimate strength approach was judged best suited to predict the relative strengths of the upper and lower portions and it was used in this design. Parallel calculations based on the working stress method gave a reasonable check. As stress increases in a chimney are not directly proportional to increase in moments, it appears that application of the ultimate strength method would be well suited to assure uniformity in load factor or strength throughout the height. (auth)

6286 REFUELING APPARATUS AND METHOD FOR FAST REACTORS. Germer, John H. (to United States Atomic Energy Commission). U. S. Patent 3,600,277. 17 Aug 1971. Filed 2 Oct 1968.

An apparatus and method are described for transferring fuel bundles in and out of the core of a sodium-cooled fast reactor, utilizing an inert gas filled refueling cell above the reactor and a removable shield plug between the reactor and the refueling cell. Fuel handling is accomplished by a refueling apparatus consisting of two mechanisms, one of which takes fuel bundles between a storage area and a temporary position adjacent to the reactor, and the other transfers fuel between this temporary position and the reactor core while maintaining the fuel elements submerged in the sodium coolant for permitting continuous removal of decay heat therefrom. (Official Gazette)

6287 240 MW(e) PROTOTYPE FAST REACTOR AT DOUNREAY. PART 2. Steam Heat. Eng.; 41: No. 480, 38-42(Nov 1971).

Brief descriptions are given of the secondary circuit, including steam generators and turbines; off-load refuelling, monitoring of sodium impurities; control instrumentation; reactivity control and safety systems. The application of acoustic listening devices for studying reactor performance is explained and reference is made to pre-operation engineering tests. (UK)

6288 IMPROVEMENTS IN NUCLEAR POWER STATIONS. Isberg, Per Gustaf; Pind, Christen Willemoes; Sundqvist, Cnut Herbert (to Allmaenna Svenska Elektriska Aktiebolaget). British Patent 1,253,136. 10 Nov 1971. Priority date 28 Mar 1968, Sweden.

REACTORS, POWER—engineered safeguards for underground, design characteristics of (D.L.C.)

6289 ENGINEERED SAFEGUARD SYSTEM FOR NUCLEAR POWER REACTORS. Tagami, T.; Fujie, H. (to Hitachi Ltd.). Canadian Patent 879,992. 31 Aug 1971. Priority date 17 Apr 1967, Japan.

The system comprises a fluid-tight containment chamber disposed outside the reactor vessel. This containment chamber houses the principal coolant conduit section of coolant ducts including a top header, a bottom header with a duct joining them and a pool disposed above the containment chamber and containing an auxiliary coolant. The wall between the pool and the containment chamber is so constructed that a portion of it is forced to open when the pressure in the containment chamber rises above a certain value. Thus, in the event of a rupture in the principal coolant section, the partition wall is provided with a port and a shut-off valve in the port. The valve is designed to open in the event of an abrupt pressure rise in the containment chamber, thereby permitting flow of auxiliary coolant from the pool into the containment chamber. This has the effect of submerging the principal coolant conduit section with auxiliary coolant. (F.S.A.) (Canada)

6290 COOLING ARRANGEMENTS. Blackburn, Michael; Wheeler, David John (to English Electric Co. Ltd.). British Patent 1,250,009. 20 Oct 1971. Filed 20 Jun 1968.

Reference is made to nuclear fuel transfer containers for carrying an irradiated fuel heat source immersed in liquid coolant. The container described has an internal tubular chimney adapted to receive the heat source at such a position that when the container is filled with fluid the heat from the source causes heated fluid to circulate through the chimney and between the chimney and the container wall. The coolant may be liquid Na. The chimney may comprise a double walled cylinder with the space between the walls filled with low pressure inert gas. The material of the chimney may be a refractory ceramic. Predictable and fairly even heat transfer characteristics are claimed. (UK)

6291 TRITIUM IN MOLTEN-SALT REACTORS. Briggs, R. B. (Oak Ridge National Lab., Tenn.). Reactor Technol.; 14: No. 4, 335-42(Winter 1971-1972).

Molten-salt breeder reactors are expected to generate tritium at a rate of about 1 Ci/MWd(t). Neutron reactions with lithium, an essential ingredient of a breeder fuel salt, are the major source of the tritium. At 800 to 1300°F, the operating temperature range of molten-salt reactors, tritium tends to diffuse through the metal walls of the reactor equipment and piping into the surroundings. Measurements of the tritium distribution in the Molten-Salt Reactor Experiment (MSRE) indicated that about 20% of the tritium escaped from the reactor systems in this way. A method was developed for calculating the distribution of tritium in the MSRE, and reasonable agreement with the measured distribution was obtained by adjusting parameters in the equations. When the same methods were used to calculate the tritium distribution in a large molten-salt breeder reactor, the calculations indicated that most of the tritium might diffuse into the steam-power system of current plant designs. Several modifications in plant design, or in operating conditions, have the potential for confining substantially all the tritium to the reactor systems and containment cells. Research is in progress to provide the data necessary to design a plant for suitable containment and disposal of the tritium. 15 references. (auth)

6292 REVIEW OF REACTIVITY METERS FOR OPERATIONAL FAST BREEDER REACTORS. Lehto, Wayne K.; Cohn, C. E. (Argonne National Lab., Ill.). Reactor Technol.; 14: No. 4, 345-53(Winter 1971-1972).

The present techniques for continuous reactivity monitoring are discussed, and their applicability to fast breeder reactors is evaluated. The methods reviewed are those based on the solution of the kinetics equations and those based on measurements of the inherent fluctuations in the mean neutron level. Although no technique is clearly preferable in all applications, meters based on the solution of the kinetics equations appear to be more suitable for reactivity monitoring at power. Because of detector-efficiency limitations, meters based on the noise techniques appear to be impractical for providing a rapid indication of reactivity. A brief review of recent work in fast reactor subcritical measurements is also included. 38 references. (auth)

6293 KRYPTON-XENON REMOVAL SYSTEMS. Keilholtz, G. W. Nucl. Safety; 12: No. 6, 591-9(Nov-Dec 1971).

The need for more electric power and the corresponding increase in the number of nuclear power reactors and fuel-recovery plants make it desirable to have near-zero release of fission-product gases to the atmosphere. Systems for retaining and storing radioactive xenon and krypton have been developed, and four of the most promising methods capable of full-scale application are described. Current systems involve one or more of the following processes: adsorption on charcoal at ambient or lower temperatures; cryogenic distillation without charcoal; separation by permselective membranes; and selective absorption of krypton and xenon in fluorocarbon solvents. 30 references. (auth)

6294 IEEE TRIAL-USE CRITERIA FOR THE PERIODIC TESTING OF NUCLEAR POWER GENERATING STATION PROTECTION SYSTEMS. IEEE Std 338 1971. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 11p.

Minimum requirements for the safety-related functional performance and reliability of the protection system for stationary, land-based nuclear reactors producing steam for electric power generation are presented. These requirements include, but are not limited to, the capability for testing the protection system. (auth)

6295 IEEE TRIAL-USE GUIDE FOR TYPE TESTS OF CONTINUOUS-DUTY CLASS I MOTORS INSTALLED INSIDE THE CONTAINMENT OF NUCLEAR POWER GENERATING STATIONS. IEEE Std 334 1971. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 12p.

Tests are described that will yield data which verify that Class I continuous-duty electric motors installed within the containment of nuclear power generating stations are capable of operating under design basis event conditions. (auth)

6296 IEEE GUIDE FOR SEISMIC QUALIFICATION OF CLASS I ELECTRIC EQUIPMENT FOR NUCLEAR POWER GENERATING STATIONS. IEEE Std 344 1971. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 11p.

Procedures are described that will yield data which verify that the Class I electric equipment can meet its performance requirements during and following a design basis earthquake. This guide may be used by equipment manufacturers to establish procedures that will yield data to substantiate performance claims or by equipment users to evaluate and verify performance of representative devices and assemblies as part of an overall qualification effort. (auth)

6297 EQUIPMENT FOR REPLACING FUEL ELEMENTS IN A NUCLEAR REACTOR. mueller, Arno (to Gesellschaft fuer Kernforschung mbH). German Patent 1,297,778. 19 Jun 1969. Filed 16 Jan 1965. (In German).

An apparatus for replacing fuel elements in a liquid-cooled nuclear reactor is described. During fuel element transfer the liquid coolant level in the reactor is dropped considerably below its customary operating level. The transfer tube carrying the fuel element becomes filled with coolant, thereby further cooling the fuel element. A coolant hold-up tank is connected to the downstream side of the heat exchanger and receives the excess displaced coolant. (K.S.W.)

6298 EMERGENCY COOLING SYSTEM OF A GAS-COOLED REACTOR. (to Gutehoffnungshuette Sterkrade AG). German Patent 1,539,987. 2 Oct 1969. Filed 9 Mar 1966. (In German).

An emergency cooling system for gas-cooled reactors is described. The system is provided with two interlocked gas circuits. One leads to the reactor and the other contains at least one heat exchanger and at least one compressor. (tr-auth)

6299 EQUIPMENT FOR MONITORING THE RADIOACTIVITY OF COOLANT IN A NUCLEAR REACTOR. Hackney, Stanley (to United Kingdom Atomic Energy Authority). U. S. Patent 3,612,860. 12 Oct 1971. Priority date 14 Aug 1967, Great Britain.

Equipment is described for testing for failed nuclear reactor fuel elements. The equipment takes samples of coolant from individual fuel elements or groups sequentially to a first detector for detecting such radiation as would be associated with a coolant sample from a failed element. The bulked remaining samples are taken to a second separate detector and then the sequentially selected sample is joined to the bulked samples after passing the first detector. The described equipment is particularly suitable for employment with a liquid metal cooled fast nuclear reactor. (auth)

Operation and Economics

Refer also to abstract 6351.

6300 (BNWL-SA-2460) DECONTAMINATION OF WATER-COOLED NUCLEAR REACTORS: STATUS AND FUTURE RESEARCH. Ayres, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 26 Jun 1969. 15p. Dep. NTIS.

Procedures for decontaminating pressurized or boiling water reactors, problems still remaining, and possible solutions that merit investigation are described. 9 references. (auth)

6301 TEST OPERATION OF BWR NUCLEAR POWER STATION. Nakajima, Yutaka (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan); Adachi, Yuzuru; Hanada, Kiyoshi; Shunami, Yoshio. Toshiba Rebyu; 26: No. 7, 841-5(Jul 1971). (In Japanese).

With the intention of elevating the plant test operation technique, Toshiba participated in the operation tests for JAPC-II, Fukushima-I, and Oyster Creek N. P. S., and noticed some differences of testing processes between conventional thermal power stations and nuclear power stations. The standard point of view on the way of planning and carrying out plant test operation is described. (auth) (Japan)

6302 APPLICATION OF LINEAR PROGRAMMING TO IN-CORE FUEL MANAGEMENT OPTIMIZATION IN LIGHT WATER REACTORS. Sauar, T. O. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng.; 46: No. 2, 274-83(Nov 1971).

The evolution of a systematic procedure for fuel cycle optimization and a new approach using a linear program for optimal fuel allocation is presented. The process of loading, operating, and refueling a power reactor is viewed as a multistage decision process where each stage or cycle corresponds to a partial refueling of the core and the subsequent operating period, and the objective to be minimized is unit fuel cost. In the overall optimization procedure, k_∞ is the state variable of the process and the power control problem is separated from the optimization process. Hence, precalculated results can be used in relating the attainable exposure distribution in a cycle and the resulting power distribution to the k_∞ distribution at end of cycle. Interactive graphics have considerable merit in searching for feasible k_∞ distributions. Dynamic programming has been applied to this process for certain limited loading schemes. The complexity of the decision vector with a general fuel location matrix led to abandonment of this approach and development of a linear program for optimal fuel allocation. The linear program selects reloading patterns for a few-region core model which minimize the present worth weighted total fuel cost, subject to the constraints of required region fuel loading and k_∞ for each stage. It is sufficiently fast to be used as a subroutine in a systematic search for the global optimum of the remaining parameters of the decision vector, such as cycle period, region exposure, region k_∞, and fuel enrichment. An iterative overall fuel cycle optimization procedure is outlined where coefficients of the reactor model in the linear program are modified by the results from higher level burnup programs. 8 references. (auth)

6303 WASTE HEAT DISPOSAL FROM POWER GENERATING STATIONS. Brown, F. Stewart (Federal Power Commission, Washington, D. C.). J. Power Div., Amer. Soc. Civil Eng.; 96: No. PO3, 277-86(Jun 1970).

Methods for disposing of waste heat from nuclear power plants are described. The effects of nuclear power plant operations on the environment are analyzed. Standards for regulating thermal discharges from power reactors are discussed. (D.C.C.)

Safety and Siting

Refer also to abstracts 4266 and 4267.

6304 (CEA-CONF-1867) PARASEISMIC PRECAUTIONS FOR NUCLEAR REACTORS. Costes, D. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 24p. (In French). (CONF-710903-5). Dep. NTIS (U. S. Sales Only).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A compendium on seismology and the subsequent problems introduced into atomic engineering is presented, particular emphasis being given to French problems. The following topics are discussed: earthquake origin, wave propagation, use of a reference earthquakes in calculations, spectral analysis, and resonance techniques, various mathematical models for earthquakes, soil foundation interactions, structural responses, and the regulations. Seismological calculations made for the primary system of the Phenix reactor are briefly reviewed. A major problem in nuclear engineering is the definition of the size of the seismic activity with respect to which the reactor will remain safe. The

acceptance of lower limits in low seismological activity areas means accepting some level of risk. (France)

6305 (GEAP-10221-8) DEFICIENT COOLING EIGHTH QUARTERLY PROGRESS REPORT, APRIL 1-JUNE 30, 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Contract AT(04-3)-189. 35p. Dep. NTIS.

The transient flow (on-off-on) single-rod water-steam critical heat flux (CHF) data were reduced and indicate the heat transfer was better than expected. Flow decay tests were made with Freon 114 to measure the response of the exit void fraction and test the prediction capability of the MAYU code. The data trends were predicted well. Single-rod steady-state CHF data were taken at 800 and 1000 psia with a symmetrical and bowed rod having an axial heat flux variation similar to a ½ sine wave. The effect of the bow was to reduce CHF about 10%-15% in the 5%-20% steam quality range. The ½ sine CHF data were about 15% higher than that of a uniform heater 9 feet long at the same quality. (auth)

6306 (NP-19118) REPORT ON THE CALCULATION OF SEVERAL EXPERIMENTS ON SIMULATION OF SEVERE HYPOTHETICAL ACCIDENTS OF FAST REACTORS ON THE TREAT REACTOR. Kuczera, B.; Struwe, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Aug 1971. 25p. (In German). Dep. NTIS (U. S. Sales Only).

During the TREAT-series of experiments for the model simulation of severe hypothetical accidents for fast reactors, very small mechanical conversion factors were found. One possible explanation for these small values could be that all the sodium was expelled from the heated zone of the pins before the pins burst. Calculations with TIGER and RADYVAR 2 for the experiments S3 and S4 (very critical in this sense) have shown that in all probability the sodium was not expelled from the heated zone before the pins burst. There are some difficulties in translating the measured small mechanical conversion factors of the TREAT-experiments to the situation of a fast breeder reactor (as e.g. SNR) because of the very different geometry of the model simulation and the geometry of a fast breeder reactor. 4 references. (auth)

6307 DECAY ENERGY RELEASE RATES FOLLOWING SHUTDOWN OF URANIUM-FUELED THERMAL REACTORS. ANS-5.1 1971. Hinsdale, Ill.; American Nuclear Society (1971). 7p.

Values for the total energy release rate from isotope decay following shutdown of thermal reactors fueled with uranium (^{235}U and ^{238}U mixtures) are stated. The energy from the decay of fission products is presented as a standard curve. Equations for the energy releases from decay of ^{239}U and ^{239}Np are included. (auth)

6308 RADIOLOGICAL SAFETY AND NUCLEAR PLANT PROJECTS. Duverger de Cuy, G.; Guirlet, J.; Japavaire, R.; (and others) (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 21-33(Apr 1971). (In French).

Typical accidents and their radiological consequences are studied; examination of the working conditions in plants led to the definition of different zones; such definitions are dependent upon the radiation risks and the degree of contamination associated with the different zones. Radiological safety depends upon the confinement and ventilation facilities in the different parts of the plant. Everyday running conditions can be checked using appropriately placed measurement devices or alarms. Special attention is given to systems for handling highly radioactive material (spent fuel assemblies for example) since they involve nonroutine operations and in consequence present special risks. Problems arising from radioactive wastes (gaseous, liquid, and solid) are discussed. (France)

6309 SAFEGUARD SYSTEM FOR NUCLEAR POWER REACTORS. Tagami, T. (to Hitachi, Ltd.). Canadian Patent 879,991. 31 Aug 1971. Priority date 17 Apr 1967, Japan.

The system comprises a pool disposed around the reactor vessel. It contains an auxiliary coolant, within which is submerged the principal coolant conduit section which includes a top header, a bottom header and a main coolant duct between and connected to, the two headers. By this arrangement, the coolant at high temperature and pressure which is discharged from a rupture point, should such a rupture occur in the principal coolant conduit section, flows first into the auxiliary coolant and is thereby cooled, thus relieving an objectionable pressure increase in the space within the containment vessel. Further, any radioactive materials which may be discharged with the leaking coolant are retained within the auxiliary coolant, thus reducing to a minimum the scattering of such materials. Complete loss of coolant in the pressure tubes in such a situation is prevented, since there is a flow of auxiliary coolant into the pressure tubes from the point of rupture; this ensures that there is always coolant in the pressure tubes, and obviates meltdown of the fuel elements. (F.S.A.) (Canada)

6310 THEORETICAL ASPECTS OF RADIOLOGICAL SAFETY STUDIES IN INSTALLATIONS AND THE USE OF AN ELECTRONIC COMPUTER. Bessis, J.; Lemenez de Kerdelleau, J.; Mairet, G.; Salle, R. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 158, 15-20(Apr 1971). (In French).

Theoretical studies undertaken by the SESR (radiological safety studies group) are discussed. Some of the most recent work is presented: the PILAX program for calculating the radiological consequences of an accident: the PROFIS program for estimating the fission product activities accumulated in the reactor fuel when irradiated under various conditions. A formula was established for evaluating the fission product concentration, at various points in the loop circuit, as a function of time. The deposit on the tube walls is being studied; straight sections and bends have been considered; at present vessels are being studied. (France)

6311 NUCLEAR SAFETY. VOLUME 12, NUMBER 6. Cottrell, Wm. B.; Blakely, J. P.; Jordan, W. H.; Savolainen, A. W. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Nov-Dec 1971). 134p. GPO $0.60.

Separate abstracts are presented for 8 articles concerning general safety considerations, accident analysis, control and instrumentation, plant safety features, consequences of effluent release, and operating experiences. (D.C.C.)

For abstracts of individual papers see: 4534, 6251, 6293, 6312, 6313, 6361, 6372, and 6396.

6312 QUALITY-ASSURANCE STANDARDS AND PRACTICES. Langston, Merritt E. (Atomic Energy Commission, Washington, D. C.). Nucl. Safety; 12: No. 6, 549-52(Nov-Dec 1971).

The U. S. Atomic Energy Commission has been taking many positive strengthening actions to establish and enforce a systematic, disciplined approach to the assurance of quality in advanced reactors and test facilities to provide for safe, reliable, and economic operation in a timely and predictable manner. Some of these strengthening actions directed toward the development and application of quality-assurance standards and practices for advanced reactor development and technology programs are described. The assistance rendered to the ANSI Subcommittee N45-3 in the preparation of industry standards is reviewed. 10 references. (auth)

6313 EFFECTS ON ORGANISMS OF ENTRAINMENT IN COOLING WATER: STEPS TOWARD PREDICTABILITY. Coutant, Charles C. Nucl. Safety; 12: No. 6, 600-7(Nov-Dec 1971).

Models are being developed at Oak Ridge National Laboratory and elsewhere for predicting ecological effects of thermal shocks received by organisms passing through thermal-power-plant cooling systems. The models were developed initially for studying directly lethal effects, but they are applicable to such sublethal effects as equilibrium loss and increased susceptibility to predation. These predictive models and the basic biological data required for use of them provide for selection of limits of temperature elevations and durations of exposure to warmed water at power plants which will prevent detrimental effects. 30 references. (auth)

6314 ASEISMATIC DESIGN OF ATOMIC POWER PLANTS. Ohno, Tokue (Ministry of International Trade and Industry, Tokyo). Karyoku Hatsuden; 22: No. 4, 349-58(Apr 1971). (In Japanese).

The problems on the aseismatic design of nuclear power plants are discussed. The assumption of design earthquakes and selection of earthquake waves in various situations are analyzed. The necessity of analyzing vibrational behavior of system components dynamically in addition to static analysis is discussed. The development of computational codes for the aseismatic design of atomic power plants is described. Selection of allowable stress for the system components and general problems arising in construction are also discussed. (Japan)

6315 SYSTEM SAFETY ANALYSIS. Mieze, G. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Kerntech. Atomprax.; 13: No. 9, 373-80(Sep 1971). (In German and English).

The safety aspects of a system as it affects all the stages of design, construction and operation are analyzed. This includes the discussion of the information data and evaluation criteria required for safety requirements and of the methods for obtaining the necessary information data. 5 references. (auth)

6316 PRELIMINARY HAZARD ANALYSIS. Mieze, G. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Kerntech. Atomprax.; 13: No. 9, 381-6(Sep 1971). (In German and English).

Preliminary hazard analysis is an inductive analysis method for obtaining qualitative information data on the safety of a system. The basic principles of the analysis method are described. Suggestions regarding a systematic analysis technique are presented. (auth)

6317 ROLE OF WATER MODEL EXPERIMENTS IN FAST REACTOR SAFETY STUDIES. Hall, R. S. (Berkeley Nuclear Labs., Eng.). J. Brit. Nucl. Energy Soc.; 10: No. 4, 299-307 (Oct 1971).

The importance of the sub-assembly accident in the context of fast reactor safety is indicated and the critical path of events during its development are given. The fast reactor safety topics under study at Berkeley Nuclear Laboratories are then described within this framework. These include: bubble growth and collapse with particular reference to boiling noise detection; local boiling, voiding and re-entry processes; fuel-coolant thermal interactions. Water is used as the working fluid because of the relative ease of providing satisfactory instrumentation and visualization of experiments; it is shown that direct relevance to sodium problems can be maintained. (auth)

Power Conversion Systems

6318 (AECL-4053) MICRETE 4: BASIC THEORY. Stewart, J. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 33p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The programs MICRETE 1, 2 and 3 obtain the macroscopic flux distribution in a rod lattice reactor by representing the thermal neutron absorption and fast neutron production in any rod by a line sink for thermal neutrons and a line source for fast neutrons. In MICRETE 4 these sources and sinks are spread out in such a way as to better represent the actual situations; the infinite fluxes on the rod axes are eliminated and the thermal source distribution caused by the fast neutrons from a rod is more realistically reproduced. MICRETE 4 allows the slowing-down area to vary from cell to cell. It also allows a radial reflector with properties different from those of the moderator and with arbitrary linear homogeneous boundary conditions on the fast and thermal fluxes at its outside radius, and the theory of the effect of this reflector takes some account of asymmetry in the constitution of the core. (auth)

6319 (JAERI-1215) ONE-DIMENSIONAL, MULTIGROUP, NEUTRON DIFFUSION THEORY CODE. Ise, Takeji; Kubo, Atsuhiro (Japan Atomic Energy Research Inst., Tokyo). 2 Mar 1971. 26p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

GURNET is a multigroup diffusion theory code for one-dimensional reactor analysis, main features of the code are: calculational capability in all four types of the standard geometries of slab, sphere, cylinder, axial cylinder (a kind of slab); scattering-transfer of neutrons allowed between all groups; calculational capability of adjoint as well as normal flux; energy-dependent albedo-type boundary conditions at the inner and outer boundaries; optional use of macroscopic cross sections or microscopic cross sections; capability of reading input flux guess and of punching the output fluxes for subsequent input to GURNET; material-dependence of the fission spectrum; and convenient input form for users familiar with AIM-6 and FOG. CDC (3600, 6600) versions are available. (auth)

6320 DIVIDED STEAM SYSTEM FOR HTR. Nucl. Eng. Int.; 16: No. 184, 788-9(Sep 1971).

A HTR concept, developed by British Nuclear Design and Construction, is described in which the steam system is divided into four main boiler reheat units for the main turbine supply and four simpler non-reheat boilers to drive small turbines for essential electrical supplies. Main features are described, which include the use of an integrated gas circuit system in a prestressed concrete vessel, with pod boilers, a completely replaceable prismatic graphite core, and a downward flow of He coolant. Advantages of the system are stressed. (UK)

6321 CHARACTERISTICS OF AN INSTALLATION EMPLOYING A CO_2 GAS TURBINE CYCLE RUNNING AT OVER-CRITICAL PRESSURE. Pfost, H.; Seitz, K. (Firma Kraftwerk Union, Erlangen, Ger.). Brennst.-Waerme-Kraft; 23: No. 9, 400-5(Sep 1971). (In German).

In the course of investiations on sodium cooled fast breeder reactors the possibility of using a CO_2 gas turbine installation at over-critical pressure was considered. The thermodynamic characteristics of such an installation are described from the points of overall design and partial load operation, and also their effects on the design of the turbine. The factors which concern the heat exchangers are discussed. The dynamic requirements are pointed out. 10 references. (auth)

6322 NUCLEAR POWER PLANT INCORPORATING LOW-PRESSURE CO_2-GAS TURBINE-CYCLE. Chermanne, J. (Belgonucleaire, Brussels). Brennst.-Waerme-Kraft; 23: No. 9, 406-12(Sep 1971). (In German).

The classical concept of the Na-cooled fast reactor with three-fold cycle ($Na/Na/H_2O$) can be replaced by a simpler Na/CO_2-system with a single secondary CO_2-gas turbine cycle. The proposed gas turbine cycle is a conventional cycle with the relatively low maximum temperature of the CO_2 of 520°C incorporating 3 compressors and 2 intermediate coolers and obtaining a net efficiency of approx. 31%. (auth)

6323 IMPROVEMENTS IN THERMAL POWER PLANTS. Hryniszak, Waldeman (to Clarke Chapman-John Thompson Ltd.). British Patent 1,251,491. 27 Oct 1971. Filed 8 Aug 1967.

The object of the system described is to provide a power plant in which heat energy is developed in a gas cooled reactor in such a way as to meet intermittent peak demands in an efficient way. The hot coolant gas from the reactor is intermittently raised to a higher temperature by addition of further heat energy in its passage to a working stage of the plant in order to increase the output from that stage. A higher efficiency is obtained than would be available by using an independent (e.g., gas turbine) power plant to increase the total power output at times of peak demand. The additional heat may be derived from the products of a combustion process, that after heat exchange with the main flow of coolant gas, may be circulated to an auxiliary working stage wherein they are used to compress the air for the combustion process. Alternatively, the reactor coolant gas may itself comprise the products of combustion of natural gas or other primary fuel, intermittently augmented by direct admixture of fresh products of combustion at a higher temperature. A proportion of the mixture may be bled off from the working stage for compression of air for the combustion process, and then exhausted to atmosphere. Operation may be automatic. (UK)

6324 IS THE CO_2 GAS TURBINE CYCLE AN ECONOMICAL PROPOSITION FOR SODIUM COOLED FAST BREEDER REACTORS? Watzel, G. V. P. (Rheinisch-Westfaelische Elektrizitaetswerk AG, Essen). Brennst.-Waerme-Kraft; 23: No. 9, 395-400 (Sep 1971). (In German).

In some cases the use of the gas turbine cycle can be considered even if operation is at low temperature and in spite of the consequent lower efficiency. The operating conditions of two CO_2 cycles working at different pressures are examined with reference to a nuclear power plant employing a sodium cooled fast reactor. It appears that, at the working temperatures considered, the steam cycle, with which comparison is made, remains more economical in spite of its more complicated overall design. 4 references. (auth)

Research and Test Reactors

Refer also to abstracts 4493, 4983, 5947, 6230, 6250, 6272, 6306, 6312, 6368, and 6370.

6325 (ANL-6732) CRITICAL STUDIES OF A 440-LITER FAST-REACTOR CORE FUELED WITH URANIUM ENRICHED TO 17 PERCENT (ZPR-3 ASSEMBLY 41). Hess, A. L.; Gasidlo, J. M.; Long, J. K.; Amundson, P. I.; Keeney, W. P. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 77p. Dep. NTIS.

ZPR-3 Assembly 41 was a cylindrical fast-reactor system composed of a dilute uranium core surrounded by a thick, depleted-uranium blanket. The fuel, a five-to-one mixture of ^{238}U and ^{235}U, amounted to 35 vol % of the core, and this was diluted with 18 vol % aluminum, 14 vol % steel, and 33 vol % void. A critical mass of 494 kg of ^{235}U was measured for this composition. Basic physics experiments included measurements of spectral indices, material reactivity coefficients, and flux profiles. The worths of steel and aluminum as reflectors, relative to uranium, were investigated in radial and axial blanket regions. Studies were carried out to determine the relative merits of three breeder-blanket concepts: an EBR-II-type blanket (with 40 vol % uranium, 40 vol % sodium, and 20 vol % steel); a UC-type blanket (with 20 vol % uranium, 20 vol % carbon, 40 vol % sodium, and

20 vol % steel); and a two-zone blanket with an inner zone of EBR-II-type blanket and an outer zone containing graphite instead of uranium. Worths of boron carbide near the core in two blanket types were measured to evaluate a rotary-control-rod concept for fast reactors. Experimental details and the results of all measurements are presented. 11 references. (auth)

6326 (ANL-EBR-40) EVALUATION OF THE EBR-II REACTOR-BUILDING ISOLATION SYSTEM. EBR-II Project. Haroldsen, R. O. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jun 1971. Contract W-31-109-eng-38. 56p. Dep. NTIS.

Since the original construction of the EBR-II plant, several changes and additions have been made that have implications relating to the isolation system. During this same period, the EBR-II reactor has been redirected toward a mission of an irradiation facility, and several new pertinent standards have been adopted by the industry. The entire isolation system was given a complete review to determine its adequacy and reliability in the light of these changes. The results of this review are given along with recommendations for upgrading the system. Increased coverage by radiation monitors, removal of the temperature trip monitors from the trip circuit, and use of two-out-of-three trip logic are recommended to upgrade the system and reduce the probability of spurious trips. (21 references) (auth)

6327 (DOCKET-50231-104) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Change No. 7. (Division of Reactor Licensing (AEC), Washington, D. C.). 2 Dec 1971. 2p. Dep. NTIS.

A revised technical specification is presented concerning the liquid sodium flow rate limits for the pump-around loop. (D.C.C.)

6328 (EIR-194) INVESTIGATION OF CORROSION PHENOMENA AT SHIELDING IN RADIATION CHANNEL OF NUCLEAR REACTORS. Hermes, E.; Gamsjaeger, H.; Peng, K.; Widder, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb 1971. 31p. (In German). Dep. NTIS (U. S. Sales Only).

For experiments in the horizontal radiation channels of the reactors SAPHIR and DIORIT, special steel shielding was used, some of which was constructed in the form of collimator plugs. To decrease the fast neutron flux, the plugs had to contain moderator material. As moderator material, wood was found unsuitable and was replaced by polystyrene. Several of the plugs showed corrosion defects that, probably, were caused by substances released from the polystyrene. These corrosion effects were studied in detail and construction principles for plugs with moderators were outlined. 11 references. (H.B.G.)

6329 (HEDL-TME-71-146) 217-PIN WIRE-WRAPPED BUNDLE COOLANT MIXING TEST. Collingham, R. E.; Thorne, W. L.; McCormack, J. D. (Hanford Engineering Development Lab., Richland, Wash.). Nov 1971. Contract AT(45-1)-2170. 227p. Dep. NTIS.

The results of a coolant mixing test in a wire-wrapped, 217-pin, full-scale model of an FTR fuel assembly are presented. Salt-injection-conductivity techniques were employed using water as the coolant. 464 conductivity probes were placed in a 1/6th sector at various axial locations. The results were reduced into an effective turbulent mixing model and the limitations of this model described. A wire-wrap, forced diversion crossflow model was presented which was qualitatively supported by the results. Mixing on a gross basis in this wire-wrapped bundle was three to four times the natural turbulence level; thus the mixing was significant, but insufficient to directly temper thermal effects across the fuel assembly. (9 references) (auth)

6330 (IAE-2020) OPERATIONAL PECULIARITIES OF PULSED FAST REACTOR FUEL ELEMENTS. Kovalevich, O. M. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 44p. (In Russian). INIS.

Problems connected with rapid heating of a fuel element core by fast neutrons in a pulsed reactor are discussed. The impulse is determined which is transmitted to the core from the side of a rigid support during the relaxation of thermal stresses. The height and time of displacement of an elastic core are evaluated. Attempts were made to determine the core behavior when composed of a large number of tablets. Correlations were obtained which characterize operating conditions in a pulsed assembly of the lower supporting lattices of the reactor core. (tr-auth)

6331 (LIB/Trans-395) SIMPLIFIED METHOD FOR LEAK TESTING OF THE DR-3 CONTAINMENT. Haack, K. Translated for Australian Atomic Energy Commission Research Establishment, Lucas Heights, from report RISO-M-597. 9p. Dep. NTIS (U. S. Sales Only).

An evaluation of the methods available for leak testing large volumes is made together with the selection of the parameters necessary to determine a leak rate in the order of 2% per 24 hours. The reference vessel method is chosen as the best suited and an outline of the method and the arrangement is given. The uncertainty of the method is calculated to 0.5%. 8 references. (auth) (Australia)

6332 (ORNL-TM-3446) PREIRRADIATION DATA FOR ORNL SERIES II AND B AND W OXIDE FUEL TESTS IN EBR-II. Olsen, A. R. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 163p. Dep. NTIS.

The data are presented to satisfy the requirements for approval of irradiations in the EBR-II. The subassembly includes $(U,Pu)O_2$ fuel pins fabricated by Babcock & Wilcox and Oak Ridge National Laboratory. The objectives of the tests, a performance and safety analysis for the subassembly, and the as-fabricated fuel pin descriptions together with the appropriate fabrication procedures and Quality Assurance documentation are presented. The analysis predicts safe operation of these experimental pins to burnup levels of 100,000 MWd/metric ton of U + Pu at a nominal peak linear heat rate of 14 kW/ft with cladding temperatures in the temperature range 550 to 650°C. (43 references) (auth)

6333 (ORNL-TM-3574) SAFETY ANALYSIS AND TEST SPECIFICATIONS FOR TRANSIENT TESTS OF SOL-GEL $(U,Pu)O_2$ FUEL PINS (ORNL SERIES I). Cox, C. M.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 39p. Dep. NTIS.

The preexperiment requirements for performing irradiation tests in the Transient Reactor Test Facility (TREAT) are described. The series I tests are concerned with determining the transient performance of unirradiated sol-gel-derived $(U,Pu)O_2$ fuel pins. The principal fuel variables are smear density, 81 and 88% of theoretical density, and fabrication form, pellets and Sphere-Pac. It is concluded that transient tests up to and including fuel pin failure can be safely performed. (29 references) (auth)

6334 (ORNL-TM-3638) BULK SHIELDING FACILITY QUARTERLY REPORT, JULY-SEPTEMBER OF 1971. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). 18 Nov 1971. 31p. Dep. NTIS.

The BSR operated at an average power level of 1,791 kW for 19.7% of the time during July, August, and September. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were three unscheduled shutdowns. The associated incident reports are identified. Changes as authorized by Reactor Instrument and Controls Design Change Memoranda Nos. BSR-2Mw-31, BSR-2Mw-32, and BSR-2Mw-33, were completed. The PCA was operated for three days during this quarter as a training aid for instrument engineers from the TVA Sequoyah Power Reactor. (auth)

6335 (RT/FI-(71)15) DESIGN OF AN EXPERIMENT OF MAGNETIC SCATTERING IN REACTOR. Maggioni, A.; Michelini, M.; Pedretti, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 38p. (In Italian). Dep. NTIS (U. S. Sales Only).

An experiment of magnetic scattering in reactor, under preparation for the RITMO critical facility, is described. The experiment is aimed at investigating the possibility of obtaining reactivity effects by a motionless device utilizing the magnetization of iron material conveniently shaped and properly positioned within the core of a nuclear reactor. The results of reactivity measurements and of preliminary magnetic measurements carried out to check design criteria are reported. 14 references. (auth)

6336 (RT/FI-(71)20) MAGNETIC SCATTERING IN REACTOR: CALCULATION OF THE MAGNETIC FIELD GENERATED IN AIR BY A TWO-LAYERED WATER COOLED SOLENOID. Pedretti, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 37p. (In Italian). Dep. NTIS (U. S. Sales Only).

To check the adequacy of the device to be used in the experiment of magnetic scattering in reactors, under preparation for the RITMO critical facility, calculations of the magnetic field generated in air by a two-layer, finite-length, thick solenoid were performed. The axial and radial distributions of the axial component are reported. The calculational procedure was tested by comparing the numerical results relative to a single layer solenoid with those obtained at the NASA Lewis Research Center for an identical solenoid. 6 references. (auth)

6337 (RT/ING-(71)12) EXPERIMENTAL DETERMINATION OF PRESSURE DROP OF PEC REACTOR FUEL ELEMENT.

Grazzini, R.; Tirelli, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 38p. Dep. NTIS (U. S. Sales Only).

Tests were performed to determine the pressure drop across the reference fuel element bundle of the PEC reactor. A hydraulic loop using demineralized water as a flowing fluid was used. In the range of Reynolds number investigated (3.10^4 to 10^5), the non-dimensional friction factor for the central region of fuel element bundle was found to be: $f = 0.475 \times Re^{-0.268}$. Non-dimensional coefficients were also defined and fitted for the entrance and exit sections of the fuel bundle. The coefficients were applied to the determination of the total pressure drop of the fuel element bundle. Results fell some 10 to 12% below the pressure drops calculated using de Stordeur's correlation. 24 references. (auth)

6338 (TID-25862) SURVEY OF RESEARCH REACTORS. (National Academy of Sciences-National Research Council, Washington, D. C. Committee on Nuclear Science). 1970. 38p. Dep. NTIS.

A survey of research reactor usage conducted by the Subcommittee on Research Reactors of the Committee on Nuclear Sciences of the National Research Council is presented. The survey was limited to research reactors licensed by the Atomic Energy Commission to operate in the 10 kW-10 MW (thermal power) range. Reactors operated above 10 MW are classed as test reactors and were excluded from the survey. The survey also excluded reactors located at AEC-operated laboratories. The principal factors of reactor usage surveyed were: power level; hours of operation per quarter year; number of research users; number of samples irradiated; types of facilities used; scientific disciplines of users; and kinds of research supported. When the survey began, in 1966, there were 71 licensed reactors in operation with 48 of them within the power spread specified by the survey. These 48 reactors represented a combined licensed power of 45 MW. From 32 of these reactors, representing a combined licensed power of 25 MW, data were submitted for the period October 1, 1967, through March 31, 1968, or two quarters. The locations of the 32 reactors were: university, 25; industry, 5; and government installations (extra-AEC), 2. (auth)

6339 CRYSTALLINE NEUTRON FILTERS. Catalan, M. Energ. Nucl. (Madrid); 15: No. 70, 119-26(Mar-Apr 1971). (In Spanish).

The study, design, and results obtained with thermal neutron filters developed for the TRIGA Mk3 reactor are described. Various collimation devices and quartz and bismuth crystal films were used. The exterior neutron spectrum was calculated by using a mechanical monochromator and deducing the total effective cross sections as a function of the energy. (tr-auth)

6340 CURRENT STATUS OF FAST REACTOR CRITICAL EXPERIMENTS. Nomoto, Shoji; Iijima, Tsutomu (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 10, 582-97(Oct 1971). (In Japanese).

A current survey of experimental techniques and analyses in fast critical experiments for large fast reactors is presented. It consists of four parts: (1) a review of the discrepancies observed between the calculated results and the integral data obtained by critical facilities, and the uncertainties contained in nuclear data; (2) a description of the procedures used and the problems encountered in critical experiments, especially for plutonium-fueled cores; (3) a survey of experimental techniques for the measurement of reactivity coefficients, sample reactivity worths, reaction rates, neutron spectra and kinetic parameters; (4) a discussion of problems in the analyses of experimental data. 103 references. (auth)

6341 COMPUTER APPLICATION IN THE DEVELOPMENT OF POWER REACTOR. TOSBAC 3400 IN POWER REACTOR AND FUEL DEVELOPMENT CORPORATION. Katsumura, Fumihiko (Tokyo Shibaura Electric Co. Ltd., Ome, Japan); Yanagiuchi, Setsuro; Fujita, Kazumasa; Kono, Shigemaru. Toshiba Rebyu; 26: No. 8, 1024-8(Aug 1971). (In Japanese).

A TOSBAC-3400 direct access control (DAC) system at the Oarai Engineering Center performs on-line, real-time processing of the operation data of the experimental reactor at a speed of up to the memory cycle of the computer. The contents of the on-line job and the operation results for one year are reported. (auth) (Japan)

6342 RETENTION ON ACTIVE CARBON OF CERTAIN FISSION PRODUCTS FROM THE VVR-S REACTOR. Vidrighin, R.; Ionescu, E.; Szabo, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 6, 613-20(1971). (In French).

The possibilities of detecting the gaseous fission products (xenon and krypton) in the VVR-S reactor when the fuel element cladding leaks are discussed. Qualitative radiometric measurements by means of gamma spectrometry were carried out. The results indicate that this method is sensitive and that it makes possible the detection of losses of fission products in the case where the fuel element cladding is not water-tight. 9 references. (tr-auth)

6343 EXPERIMENTATION DEVICE FOR NUCLEAR REACTORS. Haendel, Karl-Heinz (to Gesellschaft fuer Kernforschung mbH). German Patent 1,639,603. 23 Oct 1969. Filed 28 Jan 1965. (In German).

A device for the exchange of samples in experimental channels of research reactors is described. A slide bar in the channels to receive the samples and a shifting device for the slide bar outside the experimental channel are provided. (tr-auth)

6344 CANDU-OCR: PRESENT STATUS AND FUTURE POTENTIAL. Robertson, R. F. S.; Hart, R. G. J. Brit. Nucl. Energy Soc.; 10: No. 4, 279-85(Oct 1971).

Five years' operation of WR-1, a 40 MW(th) organic cooled, heavy water moderated reactor test and materials testing reactor, is described with particular reference to coolant conditions, structural materials and fuels. The advantages of the OCR, particularly the radiation-free primary circuit, are discussed and future developments indicated. The technical and economic feasibility and the potential of the CANDU-OCR successfully demonstrated in WR-I are being complemented by a conceptual design study, which will allow consideration of a 500 MW(e) demonstration plant by the end of 1972. (auth)

6345 OPERATION OF FAST BURST REACTORS. ANS 14.1 1971. Hinsdale, Ill.; American Nuclear Society (1971). 7p.

A proposed standard for the design and operation of fast burst reactors is presented. The standard is applicable to all current fast burst reactors. The standard does not apply to repetitively pulsed reactors or booster assemblies. (auth)

Rocket and Space Reactors

Refer also to abstracts 4304, 5002, and 6357.

6346 (N-71-14037) CONCEPTUAL DESIGN STUDY OF NUCLEAR BRAYTON CYCLE HEAT EXCHANGER AND DUCT ASSEMBLY (HXDA), PHASE 1. Coombs, M. G.; Morse, C. J.; Richard, C. E. (Garrett Corp., Los Angeles, Calif. AiResearch Mfg. Div.). 4 Dec 1970. Contract NAS3-13453. 346p. (NASA-CR-73783). NTIS.

Parametric data of heat exchanger size and weight for nuclear reactor Brayton cycle space power systems in the 160 kW(e) range are presented. Optimized designs of heat exchanger and duct assemblies are developed over a wide range of Brayton cycle operating conditions with particular emphasis on those associated with the SNAP-8 reactor capabilities. (auth) (STAR)

6347 (N-71-16560) PRESSURE CONTAINMENT TESTS IN SUPPORT OF THE NUCLEAR BRAYTON CYCLE HEAT EXCHANGER AND DUCT ASSEMBLY (HXDA), PHASE 2. Coombs, M. G.; Gibson, J. C.; Richard, C. E. (Garrett Corp., Los Angeles, Calif. AiResearch Mfg. Div.). 4 Jan 1971. Contract NAS3-13453. 32p. (NASA-CR-72815). NTIS.

The pressure containment capability of plate-fin heat exchangers for nuclear reactor Brayton cycle space power systems was evaluated. Representative plate-fin specimens using 347 stainless steel and Hastelloy X with a Ni base and Au base braze alloy were burst tested at room temperature and 800°F and creep rupture tested at 1200, 1350, and 1600°F. (auth) (STAR)

6348 (N-71-34600) HEAT TRANSFER OPTIMIZATION AND REACTIVITY OF NUCLEAR ROCKET REACTORS. Simpson, Terry Regg; Mason, Edward A. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Sep 1970. 246p. (NASA-CR-121735; CSR-T-70-3). NTIS.

Thesis. Submitted by Terry Regg Simpson.

A method of optimizing the axial power profile of a solid-core nuclear rocket reactor was developed. It is shown that the power profile is very dependent upon the heat transfer correlation used to predict channel wall temperatures, especially in the reactor core inlet region. It is demonstrated that the optimum reactor core dimensions and lsp are insensitive to the form of the heat transfer correlation used. Reactivity characteristics for such compact, high performance reactor cores were calculated. It is shown that the hydrogen in the reflector can contribute several times more reactivity worth than the hydrogen in the reactor core. The critical uranium concentration, total and specific hydrogen reactivity worths, and mean fissioning energy are all shown to be strongly correlated to the geometrical buckling. Several equations are derived relating hydrogen worth to geometrical buckling. The total

reactivity worth of hydrogen in the reflector is shown to be linearly proportional to the average hydrogen concentration in the reflector. Power tilting and loss of reactivity by core thermal expansion and corrosion loss of carbon are calculated. (auth) (STAR)

6349 (TID-24860) RADIATION ENVIRONMENT OF REACTORS FOR NUCLEAR ROCKET PROPULSION. Graves, Glen A. (Los Alamos Scientific Lab., N. Mex.). [nd]. 13p. (N-2-560). Dep. NTIS.

Results of systems studies on nuclear rocket propulsion show that reactors for this purpose are likely to have very high power levels, very high power densities, and thin shields. The integrated dose from such radiation sources will be comparable to any now confronting the ANP Program, but the dose rates will be orders higher. These problems are discussed as they relate to some reactors under consideration at LASL. (auth)

6350 METHOD FOR THE REGULATION OF THE ENERGY SUPPLY REACTORS IN SPACE VESSELS. Janner, Karl; Budnick, Dietrich (to Siemens AG). German Patent 1,514,432. 14 Aug 1969. Filed 7 Apr 1965. (In German).

A method for the control of a power supply reactor in space vehicles by the chemical shim principle is described. Within the reactor core a liquid metal, to which a neutron poison is added, circulates. (tr-auth)

Process Heat and Desalination Reactors

6351 (CONF-711103-2) NUPLEX CONCEPT AND ITS ROLE FOR THE FUTURE. Hammond, R. Philip (Oak Ridge National Lab., Tenn.). [1970]. 11p. Dep. NTIS.

From American Institute of Chemical Engineers meeting; San Francisco, Calif. (29 Nov 1971).

The concept of a nuclear-powered energy center and agricultural and industrial complex is described. The role of nuclear energy centers in future power economics is discussed with emphasis on the chemical process industry. (H.D.R.)

6352 PRELIMINARY ANALYSIS OF HIGH TEMPERATURE GAS REACTORS. Mochizuki, Hiroji (First Atomic Power Industry Group, Tokyo); Tanaka, Ryokichi; Izaki, Takashi; Takitani, Kooichi; Kobayashi, Takeshi. FAPIG (Tokyo); No. 60, 318-23(Feb 1971). (In Japanese).

Preliminary analysis was made on a HTGR of thermal output 50 MW to examine multi-purpose utilization such as generation of reducing gas for iron manufacturing, etc. Procedures of this analysis were as follows: design of a reactor which satisfies the requirement for output gas temperature of 1000°C; examination of lattice characteristics of the HTGR; understanding of effects of design parameters on thermal and nuclear characteristics of the core; and seeking measures for optimum design. For analysis of the thermal characteristic, the survey code for core heat flux parameter GASPAC-R was employed. Outlet gas temperature rises with rising inlet gas temperature, and the rising rate dulls with increasing core height in regard to a channel with constant thickness of fuel pellets and ratio of coolant path areas. As for analysis of the nuclear characteristics of the HTGR, mainly a survey of the lattice characteristics was carried out, and the point burn-up code PBS-II was used for calculation. PBU_s of UO_2, UC and $(U,Th)O_2$ were plotted in relation to the ratio of the number of carbon atoms to that of heavy metal. From the above results, a core for reference was designed. In this core, the outlet He gas temperature can be 1000°C, and channel forms and gas flow conditions for attaining that temperature are of wide ranges. Under the condition that the mean density of the fuel pellets is 1.58 HMg per cc, 6 percent enriched uranium can be used for this reactor. (Japan)

6353 NUCLEAR ENERGY FOR THE PRODUCTION OF STEAM AND ELECTRICAL POWER IN A LARGE CHEMICAL COMPLEX. Frank, B. (Badische Anilin- und Soda-Fabrik AG, Ludwigshafen am Rhein, Ger.). Chim. Ind., Genie Chim.; 104: No. 14, 1739-46(Sep 1971). (In French).

The Badische-Anilin and Soda-Fabrik installation in Ludwigshafen, which has a steam consumption of up to 2000 to 2500 tons/hr, and a power requirement of 700 MW(e) is sufficiently large to utilize fully the output of a 2000 MW(t) nuclear reactor throughout the year. Such a reactor would have to be situated in the production complex. Because of the associated problems, its authorization is dependent upon: the isolation of the nuclear section from external influences; safety measures concerning the release of nuclear disintegration products; safety measures in the case of the bursting of the reactors inner vessel, protection against sabotage. It is likely that construction on the BASF reactor will begin in 1972 and will be completed in 1976. (France)

Marine and Portable Power Reactors

6354 (DOCKET-50238-85) N. S. SAVANNAH. Technical Specifications, Changes to Section 7, Defueling. (Maritime Administration, Washington, D. C.). 15 Nov 1971. 12p. Dep. NTIS.

6355 OPERATIONAL GUIDES FOR NUCLEAR SHIPS AND CRITERIA FOR THEIR APPLICATION. Genshiryoku Iinkai Geppo; 16: No. 1, 26-8(Jan 1971). (In Japanese).

Operational guides and criteria for their application were formulated by the Atomic Energy Commission, based on a report by a nuclear energy safety standards group. The purpose is to ensure safety while in port and harbor with regard to the population. Fundamental conditions as to ship position, concerning the public safety, are given. As the guides of nuclear ship operation in port and harbor, the following are described: anchorage in harbors; mooring outside harbors; anchorages at a distance; navigation within harbors; and navigation along the coast. Finally, doses of radiation, as the criteria for application of the guides, are given briefly. (Japan)

6356 SECONDARY SHIELDING IN THE NUCLEAR SHIP MUTSU. Sekine, Mikao (Ishikawajima-Harima Heavy Industries Co. Ltd., Yokohama, Japan). Nippon Zosen Gakkaishi; No. 499, 3-7(Jan 1971). (In Japanese).

Installation of a nuclear plant is proceeding on the N. S. Mutsu. The secondary shielding, which required most development work, is described. Radiation sources, i.e., reactor, primary-coolant system, etc., are contained in a reactor room as far as possible, to minimize the amount of secondary shielding. To reduce weight of the shield, the effect of attenuation due to distance is utilized to the fullest extent, and unmanned rooms, for instance, are arranged around the reactor room for this purpose. The secondary shielding is described in the following: design conditions; selection of the shielding materials and their distribution; arrangement of penetrations through the shield; lead, polyethylene, concrete, and water shieldings. (Japan)

6357 PRESENT STATUS AND PROBLEMS OF NUCLEAR PROPULSION. Nippon Genshiryoku Gakkaishi; 13: No. 10, 598-607(Oct 1971). (In Japanese).

Reference is made to studies on the nuclear propulsion of space vehicles, particularly in respect of the safety of reactors, where the environment is quite different from that of ordinary power reactors. As to ship reactors, studies on the economics of nuclear propulsion are briefly summarized. On N. S. Mutsu, the progress made on its construction and future experiment programs are reviewed. Reference is made to published data from N. S. Otto Hahn operations. More advanced types of reactors, including the high temperature gas reactor, are examined for possible future application to nuclear propulsion. The results of research work related to the above mentioned developments are briefly summarized. 26 references. (auth)

6358 COLLISION-RESISTANT STRUCTURES OF THE NUCLEAR SHIP MUTSU. Nara, Shigeru (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo). Nippon Zosen Gakkaishi; No. 500, 57-61(Feb 1971). (In Japanese).

Safety against collision is fully taken into consideration in the nuclear ship "Mutsu," and collision-resistant structures are provided on both sides of the reactor room and auxiliary machinery room to protect machinery in reactor systems containing radioactive substances from collision with other ships. The collision-resistant structures can withstand collision with most ships. There are three methods to absorb collision energy effectively, and in Mutsu, side structures of the ship hull are stiffened, and capability to absorb destruction energy is improved. Estimation of the safety against collision was carried out on the basis of design data for the nuclear ship "Savannah." Studies on the collision-resistant structures were carried out in Japan. Minorsky analysis was utilized for design of the first nuclear ship. Taking prevention of crack propagation due to shock at the time of collision into consideration, types of steel plates to be used were decided. According to the safety estimation, high speed cargo liners are very dangerous, but sufficient safety was proved, by calculation and experiment, for the collision-resistant structures. (Japan)

6359 APPLICATION OF MARKOV PROCESSES TO THE RELIABILITY ANALYSIS OF A CONTROL ROD DRIVE SYSTEM. Zeibig, H.; Valentin, E. (INTERATOM, Bensberg, Ger.).

Kerntech. Atomprax.; 13: No. 9, 387-91(Sep 1971). (In German and English).

A system state analysis of the control rod drive system of the reactor of N. S. Otto Hahn is described making use of the concept of Markov processes. The mean holding time at each system state is assumed to be exponential. The analysis makes it possible to determine the reliability and the availability of the system. The results obtained show that the concept of Markov processes constitutes an important technique for analyzing complex systems, especially with regard to repair problems. The results of the calculations are in good agreement with calculations and field data for similar systems. 6 references. (auth)

Production Reactors

6360 (DP-1280) CONFINEMENT OF AIRBORNE RADIOACTIVITY. Progress Report, January-June 1971. Evans, A. G.; Jones, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct 1971. Contract AT(07-2)-1. 24p. Dep. NTIS.

Penetrating iodine compounds can be formed in carbon beds as the result of the radiation background produced by the adsorbed radioiodine. The rate of formation and desorption of these iodine compounds is a function of the radiation field strength, duration of exposure, type and service history of the carbon, and moisture content of the purge gas stream. On November 9, 1970, about 160,000 curies of particulate activity was released into the K reactor room from an irradiated antimony-beryllium source rod which melted while suspended in air. Approximately 1370 curies reached the confinement filters; only 3 millicuries escaped to the environs. (10 references) (auth)

6361 FAILURE OF N REACTOR PRIMARY SCRAM SYSTEM. Gallagher, George R. Nucl. Safety; 12: No. 6, 608-14 (Nov-Dec 1971).

The N reactor at Hanford scrammed from an operating level of approximately 450 MW at 0525 hr, Sept. 30, 1970. The reactor was in a power-holding mode with the primary loop at equilibrium flow and temperature. The scram signal was initiated by simultaneous low-flow trips on several process tubes. Owing to a unique malfunction, the rod safety system did not respond to the scram signal. Other scram trip instrumentation responded as designed, and the reactor was shutdown and maintained in a safe condition by the ball safety system. No overheating of reactor components occurred, and no radiation was released. The shutdown transient was normal in all respects. The low flow was caused by a primary pump tripping from steam-turbine-drive speed down to pony-motor electric-drive speed. The turbine trip was precipitated by one of the turbine-condenser condensate pumps losing suction because of a plugged screen. The safety rods failed to scram owing to a combination of circumstances involving the No. 59 rod assignment switch being in the Off position and there being four failed (shorted) diodes in the No. 59 rod scram circuit. This combination of events and the parallel wiring characteristics of the rod safety circuit allowed power from an auxiliary electrical circuit to feed all the rod scram solenoids and thus keep them energized after the main scram relays had tripped. (auth)

Reactor Theory

6362 ADVANCES IN THE GENERALIZED PERTURBATION THEORY. Cecchini, G. P.; Salvatores, M. (Comitato Nazionale per L'Energie Nucleare, Rome). Nucl. Sci. Eng.; 46: No. 2, 304-9(Nov 1971).

The applications of the perturbation theory for ratios of functionals and its relation with the conventional perturbation theory are discussed. Some relevant improvements are derived in connection with specific features of the iteration scheme related to the ratio perturbation theory. 23 references. (auth)

6363 MARSHAK'S AND FEDERIGHI'S BOUNDARY CONDITIONS IN THE MILNE PROBLEM OF SPHERICAL GEOMETRY. Hauptmanns, R. U. (Technische Univ., Berlin). Atomwirt., Atomtech.; 16: No. 11, 576-7(Nov 1971). (In German).

The monoenergetic stationary transport equation for spherical geometry was transformed into a system of simultaneous linear differential equations. For solution of the system, Mark's system was modified in such a way that it was applicable to the problem of a black sphere which is embedded in an infinite scattering and absorbing medium and which is irradiated from a finite neutron source at infinite distance. Numerical results are discussed and compared with literature data. (H.B.G.)

Kinetics

Refer also to abstracts 5944, 6119, and 6247.

6364 (AI-AEC-13001) EVALUATION OF SEVERAL ENDF/B-2 CROSS-SECTION SETS USING MONTE CARLO SLOWING-DOWN AGE CALCULATIONS. Alter, H. (Atomics International, Canoga Park, Calif.). 25 Jun 1971. Contract AT(04-3)-824. 18p. (ENDF-149). Dep. NTIS.

The Monte Carlo code, TYCHE4, has been used to calculate, with a high degree of convergence, the second, fourth, and sixth spatial moments of the slowing-down density distribution at the indium resonance energy, for neutrons originating from a fission source at a point in infinitely extended light water, heavy water, and graphite moderators. These calculations were carried out in support of the ENDF/B Phase-II data testing effort, and are intended to validate the changes made to the ENDF/B data file for carbon and deuterium. The calculations in light water were used as reference for possible changes in both the Monte Carlo code and the nuclear data file. The results of these calculations, based on ENDF/B Version 2 data, are compared with similar calculations based on ENDF/B Version 1 data and with experiments. For all calculations, 40,000 neutron histories were sampled, and the Cranberg ^{235}U fission spectrum used as the source distribution. In addition, calculated results for the neutron age and higher moments in light water, based on a ^{252}Cf fission source, are reported. (6 references) (auth)

6365 (ITEF-786) APPLICATION OF THE PONTRYAGIN'S MAXIMUM PRINCIPLE TO THE OPTIMIZATION OF THE REACTION RATES. Rudik, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

A useful iteration scheme is proposed for application of the Pontryagin's maximum principle to optimize the reaction rates. 4 references. (auth)

6366 (LA-4557) TIME-DEPENDENT NEUTRON AND PHOTON TRANSPORT CALCULATIONS USING THE METHOD OF DISCRETE ORDINATES. Dupree, S. A. (Naval Weapons Evaluation Facility, Albuquerque, N. Mex.); Sandmeier, H. A.; Hansen, G. E. (Los Alamos Scientific Lab., N. Mex.); Engle, W. W. Jr.; Mynatt, F. R. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-36. 18p. (ORNL-4662; SAI-70-125). Dep. NTIS.

The time-dependent discrete ordinates radiation transport computer program, Time-Dependent ANISN (TDA), is described. The results of application of the code to several nonphysical problems having approximate analytical solutions, and to the real problem of a neutron-pulsed subcritical ^{239}Pu sphere, are presented and discussed. In the latter problem, neutron and photon leakage rates are presented as functions of energy and time. The neutronic response time of this pure metal system is 10 to 20 nsec. In all cases considered, the TDA code performed well, within the discrete limitation, provided that care was taken to assure proper convergence of the S_n iteration scheme. (20 references) (auth)

6367 (RT/FI-(71)21) NEUTRON NOISE AND STOCHASTIC PROCESSES: ROLE OF THE GENERATING FUNCTION. Jorio, V. M.; Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 56p. (In Italian). Dep. NTIS (U. S. Sales Only).

The role of the generating functions of probability distributions and their corresponding moments is studied for neutron noise analysis. In particular, Poisson distribution, Bernoulli distribution, fission neutron distribution and steady-state reactor neutron distribution are analyzed. Comparisons are outlined between experimental data and expected distributions for each of the four cases. 28 references. (auth)

6368 NOISE AND TRANSIENT KINETICS EXPERIMENTS AND CALCULATIONS FOR LOOSELY COUPLED CORES. Rydin, R. A.; Burke, J. A.; Moore, W. E.; Seemann, K. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 46: No. 2, 179-96(Nov 1971).

A series of space-time reactor kinetics experiments were performed in the Solid Homogeneous Assembly. The ground rules were the following: (1) The cores were to be easy to model statically using few-group diffusion theory. (2) The dynamic behavior was to be one dimensional. (3) Significant flux tilt and delayed neutron flux tilt holdback effects were to be present. (4) The perturbation was to be essentially a negative step change in reactivity. (5) The flux distributions, absorber worths, and eigenvalue separation of each core were to be measurable in order to use this information to verify the core modeling process. The adequacy of few-group diffusion theory was checked using both

one-dimensional multigroup (fast and thermal) and two-dimensional few-group transport theory calculations. The few-group diffusion theory model was solved in a cylindrical approximation using a finite difference code, and in correct 3D geometry using a synthesis code; the latter did an excellent job of predicting criticality and matching foil activation traverses made using the $^{55}Mn(n,\gamma)$ thermal and $^{115}In(n,n')$ threshold reactions. The eigenvalue separation of each core was measured using both a static flux tilt method and a two-detector noise correlation method; the results agreed well with calculated values, indicating that these new experimental methods can provide an accurate determination of the eigenvalue separation of a core. The transient response of one of the cores to a step perturbation was compared to the response calculated using the space–time synthesis model. In general, it was found that the transient response of the core can be predicted accurately provided that the core is well modeled statically, including the perturbation worth and the eigenvalue separation, and provided that the effective delayed neutron fraction is properly evaluated. This tends to verify the adequacy of existing methods for computing spatially dependent transients in cores describable by few-group diffusion theory. (20 references) (auth)

6369 OPTIMUM BOUNDS FOR SPACE–TIME REACTOR PROBLEMS USING LINEAR PROGRAMMING. Reister, David B. (State Univ. of New York, Buffalo). Nucl. Sci. Eng.; 46: No. 2, 197-202(Nov 1971).

Optimum upper and lower flux bounds are sought for a general space–time reactor problem. The bounds are much narrower than previous bounds. Each bound is a sum of the products of known spatial modes and unknown time-dependent amplitude functions. To determine a bound, the amplitude functions must satisfy certain inequalities given by a comparison theorem of the Nagumo–Westphal type. An optimum bound is one that satisfies the inequalities and minimizes a "payoff" function. The payoff function is the weighted average of the magnitude of the bound at several points in the reactor. It is shown that an optimum bound can be determined by solving a linear programming problem at each time step. (Linear programming can be used even if there is feedback and the problem is nonlinear.) Using linear programming theory it is shown that an optimum bound always exists, although it may not be unique. Furthermore, an optimum bound satisfies the original space–time equation at each point in the reactor sampled by the payoff function. In an example, narrow bounds are determined for a difficult example in which the spatial shape of the flux changes radically with time. (16 references) (auth)

6370 REGIONAL-DEPENDENT REACTOR KINETICS. Gooden, David S.; Parkinson, T. F. (Univ. of Missouri, Columbia). Nucl. Sci. Eng.; 46: No. 2, 169-78(Nov 1971).

The space-dependent kinetics of a strongly coupled multiregion cylindrical reactor were studied both theoretically and experimentally. A three-node model was used to calculate the kinetic response in the various regions and these results were compared with two-detector noise measurements. Reasonable agreement was obtained for predicted and measured transfer functions, power spectral densities, coherence functions, and alpha, the ratio of the effective delayed neutron fraction to the prompt neutron lifetime. Differences in the kinetic response of the various regions were clearly evident. (13 references) (auth)

6371 DISADVANTAGE FACTOR IN A CELL WITH THIN MODERATOR. Takeda, Toshikazu; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 539-45(Oct 1971).

A monoenergetic disadvantage factor is introduced by extending the method of Amouyal and Benoist so as to permit the treatment of a cell with thin moderator. To take into account the flux depression in a fuel rod, the blackness of the fuel rod is introduced into the calculation as in the paper by Amouyal et al. The Wigner–Seitz equivalent cylindrical cell method is incorrect for closely packed lattices. To cover this shortcoming, an extended Dancoff factor is introduced to take into account the interference among fuel rods. This factor can be easily calculated in a homogeneous system, and so no consideration is necessary to account for the shadowing effect by other fuel rods. The result obtained is similar to that from the collision-probability method but can be calculated more easily. An improvement over the Amouyal-Benoist method is thus obtained. 10 references. (auth)

6372 SURVEY OF HEAT-CONDUCTION COMPUTER PROGRAMS. Shuker, W. A. (Bettis Atomic Power Lab., Pittsburgh). Nucl. Safety; 12: No. 6, 569-82(Nov-Dec 1971).

Many problems in reactor analysis require knowledge of the temperature variations during normal reactor transients and in accident situations. In solid bodies the heat-conduction equation describes thermal behavior. Most often a closed-form solution cannot be obtained because of complex geometries and boundary conditions, but these problems may be conveniently approximated by numerical solutions obtained on high-speed computers. Eleven heat-conduction programs reported in the literature are reviewed. All these programs approximate the heat-conduction equation in at least two dimensions under transient and steady-state conditions for general types of boundary conditions. The comparison of programs includes consideration of the method used to describe geometry, the numerical differencing method, the maximum allowable number of nodes, and the manner of specification of boundary conditions, material properties, and heat-generation rate. 19 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 4456, 4534, 4609, 4906, 4910–4912, 4922, 4923, 4928, 4989–4991, 4993, 4999, 5029, and 5032.

6373 (AECL–4056) SEGPIPE: A PROGRAM TO DETERMINE THERMO-ELASTIC DEFORMATIONS IN A SEGMENT OF A HOLLOW CYLINDER. Crozier, R. J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 44p. Dep. NTIS (U. S. Sales Only).

The Fortran program SEGPIPE is designed to determine the thermo-elastic deformations which arise in a segment of a hollow circular cylinder. The inner and outer surfaces of the cylinder are subjected to temperature changes, normal stresses and shear stresses, all of which may vary around the circumference of the cylinder. The length of the cylinder may change. The preparation of input data has been made particularly simple and the central processor time required to execute a typical problem is of the order of 15 seconds. The problem of the non-uniform heating of a fuel sheath containing an eccentrically placed fuel pellet is used as an illustration. (auth)

6374 (ANCR–1010) ANALYTICAL METHOD FOR CALCULATING STEADY-STATE FISSION GAS RELEASE–FISSION PRODUCT FUEL MODEL (FPFM) CODE. Baston, V. F.; McFadden, J. H.; Yuill, W. A. (Aerojet Nuclear Co., Idaho Falls, Idaho). Sep 1971. Contract AT(10-1)-1375. 40p. Dep. NTIS.

An analytical method based on the steady-state release model is presented for calculating noble gas and iodine release to the fuel-cladding gap of fuel pins in a nuclear reactor operating at steady-state conditions. This method, which employs fission gas capsule data and conservative assumptions (assumptions that result in overprediction of release), can be used in reactor safety analysis to predict the fission gases that could be available for release in the event of cladding failure and pressure exerted by the fission gases on the inside of the cladding during reactor operation. A summary of the specific assumptions used in development of the method, the resulting equations used for predictions, the application of the method, and the limitations of the method are presented. A FORTRAN 4 computer code, Fission Product Fuel Model (FPFM), based on the analytical method is also presented. The method described not only appears to be adequate for safety analysis but is convenient to use in that the release is related to the average heat rating of the entire pin rather than to temperature regions in the pin. The method merits consideration for both safety and fuel element design. 26 references. (auth)

6375 (CEA-CONF–1866) RUPTURE OF PRESSURE VESSEL CRACKS. Costes, D.; Dore, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 28p. (In French). (CONF-710903–4). Dep. NTIS (U. S. Sales Only).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Notch sensitivity analysis was used to study the safety characteristics of pressure components. The established theories apply only to low toughness materials (Linear Elastic Fracture Mechanics or L.E.F.M.) and to very ductile materials (similitude). The materials used in heavy construction and in the atomic energy field are intermediate between brittle and ductile and an intermediate analysis is required. The method of analysis adopted is based upon a similitude. A notch sensitivity parameter p is derived, which associates the brittleness and plasticity terms. The analysis uses published results on notched vessels and the new CEA results, tests with plain cracks and sliding patches and tests with the remaining 20 per cent ligament cracks are found to be in good agreement and to give most of the correlations. 17 references. (France)

6376 (FRNC-TH-113) MIXING BETWEEN TWO SUBCHANNELS OF A CLUSTER-TYPE NUCLEAR FUEL ELEMENT. Bousquet, Jean-Louis (Grenoble Univ. (France). Faculte des Sciences). 1969. 193p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The turbulent diffusion occurring inside the liquid phase between two identical adjacent sub-channels of a reactor with fuel element clusters was studied for the case when mixing systems are absent. Bulk and local exchanges were determined using a liquid tracer and a very simple geometry. The testing facility is described (principal characteristics and associated equipment), each type of test is described (experimental techniques and data processing), and the essential uncorrected results are presented. Analytical models are presented which explain either the local results obtained in the single phase or the overall behavior in the single or double phase. The models can be introduced in the computer codes used for fuel element clusters. 67 references. (France)

6377 (NP-19123) SEVERAL POSSIBILITIES FOR USING HIGH-RESOLUTION GAMMA SPECTROSCOPY FOR FISSION PRODUCT DETERMINATION. Wolff, Jens (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1971. 72p. (In German). Dep. NTIS (U. S. Sales Only).

The possibility of measuring nondestructively the fissile material content in fuel pins with high resolution γ-ray spectrometry is analyzed. The application of the natural γ-ray activity is discussed. In the absence of plutonium the determination of the ^{235}U content in homogeneous reactor pins is possible in less than 6 minutes with an accuracy of 1% with the aid of the characteristic 185-keV γ-line of ^{235}U. Plutonium causes an increase of compton-background and therefore the need of longer measuring-time. Plutonium is determined using the 414-keV photons emitted by ^{239}Pu. The intensity of the radiation is strong enough to achieve a precision and reproducibility of 0.5% in 10 minutes. The application of the passive γ-ray assay depends primarily on the quality of fuel homogeneity. In order to check the spatial distribution of the fissile material it is sufficient to compare the ratio of the 185-keV intensity (414-keV) to the 98, 4 keV $UK_{\alpha 1}$ radiation relative to that of the standard. This ratio turned out to be extremely dependent on the degree of inhomogeneity. Neutron-induced fission product γ-ray spectra of ^{239}Pu and ^{235}U after short term irradiation show characteristic differences. This can also be used for fissile material assays in fuel pins. 22 references. (auth)

6378 IMPROVEMENTS IN OR RELATING TO REMOVABLE COVERS FOR APERTURES IN PRESSURE VESSELS. McIver, Robert Faulds; Marchbank, Frederick Albert Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,247,689. 29 Sep 1971. Filed 10 Jun 1968.

Reference is made, in particular, to means for closing apertures in the walls of reactor concrete pressure vessels. Such closing means must allow for piping to pass through without lowering safety standards. In earlier proposals it was suggested that openings in the pressure vessel walls should be fitted with flow restrictors as well as seals, the former being intended to preclude the possibility of rapid depressurization of the primary gas circuit in the event of a rupture of the cover or its pressure seals, this adding to cost. In the cover system described the parts are held in compression, so that the compressive stress acts to counter any forces tending to rupture the cover. The closure member is of composite construction, with a metal plate as one part and a prestressed concrete plug as the other. The metal part is located on the high pressure side of the closure member and is bonded to the concrete part. Means are provided for securing the closure member to the adjacent part of the pressure vessel wall. Means are also described for reducing heat conduction between coolant and closure member. (UK)

6379 SPECIFICATION FOR CARBON AND LOW ALLOY STEEL PRESSURE VESSELS FOR PRIMARY CIRCUITS OF NUCLEAR REACTORS. BS 3915 1965. London; British Standards Institution (1965). 81p. Available from American National Standards Institute, New York.

The standard covers the design, construction, inspection and testing of all primary pressure containing parts of nuclear reactors made of carbon or low alloy steel which fall within either of the following categories: Category A. Pressure vessels and components which are intended to contain radioactive materials and are subject to neutron irradiation such that the physical properties of the materials of construction may be affected during the projected life of the nuclear installation or those which, from biological considerations of radioactivity, will be inaccessible for comprehensive periodic examination and maintenance. Category B. Pressure vessels and components which are intended to contain radioactive materials in service but which on reactor shut-down, will be accessible for comprehensive examination and maintenance at any time during the projected life of the nuclear installation. (auth)

6380 GENERAL PRINCIPLES OF NUCLEAR REACTOR INSTRUMENTATION. IEC Publication 231 1967. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1967). 34p. (In French and English). Available from American National Standards Institute, New York.

The recommendation gives guidance on the provision of reactor instrumentation and recommends standards of good practice. The main body of the recommendation is of general application. Items of instrumentation are included only where they have a direct bearing on the over-all safety and effective control of the reactor. (auth)

6381 GENERAL PRINCIPLES OF NUCLEAR REACTOR INSTRUMENTATION. IEC Publication 231A 1969. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1969). 30p. (In French and English). Available from American National Standards Institute, New York.

Recommendations on standards for nuclear reactor instrumentation are presented. Guidelines for protection systems and general alarms are included. (H.D.R.)

6382 GENERAL CHARACTERISTICS OF NUCLEAR REACTOR INSTRUMENTATION. IEC Publication 232 1966. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1966). 50p. (In French and English). Available from American National Standards Institute, New York.

Recommendations concerning the construction, quality and performance of electrical measuring assemblies used in the control and safety of nuclear reactors are presented. The variable measured may be nuclear (e.g., neutron flux or gamma radiation) or nonnuclear (e.g., temperature or pressure). In the latter case, the assembly or sub-assembly is considered only when it is part of a reactor control, instrumentation or safety equipment. (auth)

6383 REACTOR POWER LEVEL SENSING DEVICE USING CHERENKOV RADIATION. Porges, Karl G.; Gold, Raymond (to United States Atomic Energy Commission). U. S. Patent 3,600,578. 17 Aug 1971. Filed 7 Oct 1969.

A gas filled probe is positioned within a reactor to intercept gamma rays developed therein. The gamma rays above a predetermined threshold energy level develop Compton recoil electrons in the gas and tube with velocities greater than the velocity of light in the gas. The Cherenkov radiation resulting from the slowing down of the electrons is detected and measured by a photomultiplier to measure the power level of the reactor. (Official Gazette)

6384 CONTROL ASSEMBLY FOR A NUCLEAR REACTOR INCLUDING AN OFFSET COUPLING. Ripley, Charles C.; Suckow, Frederick L. (to United States Atomic Energy Commission). U. S. Patent 3,597,939. 10 Aug 1971. Filed 25 Jun 1969.

A control assembly for a nuclear reactor includes two control rods operated by a single drive shaft. The control rods and drive shaft are linked by coupling members extending radially from the control rods, one of the coupling members including two spaced arms and the other coupling member including a single arm adapted to fit between the two spaced arms, the drive shaft extending through holes in the coupling members to serve as the hinge pin of the hinge formed by the coupling members, the lower end of the drive shaft and the lowermost arm of the coupling member mating in a Christmas tree coupling. The upper and lower surfaces of the central coupling member are curved convexly to allow for vertical angular deflection between the coupling members without binding. (Official Gazette)

6385 NUCLEAR REACTOR FUEL ASSEMBLY. Murdock, Thomas B.; Fox, Jack N. (to General Electric Co.). U. S. Patent 3,607,642. 21 Sep 1971. Filed 26 Nov 1968.

An assembly comprising a plurality of rods containing fissionable material is disclosed. Typically, the fuel rods are arranged in a hexagonal parallel array with the rods spaced from each other by wires wound around and down each rod in a spiral manner. The rods are fastened only at the bottom to a plurality of spaced support bars. The assembly is surrounded by a shroud terminating in inlet and outlet orifices or transitions at the ends. The lower orifice is adapted to fit in an opening in a plate while allowing slight transverse movement of the shroud and fuel rods relative to the lower orifice. Also, improved flow and heat transfer characteristics are obtained where at least some of the wires in the row of fuel rods adjacent the assembly shrouds are formed

from thin tubes which are flattened slightly where they contact the shroud to decrease the size of the fluid flow gap between the fuel rods and the shroud. (auth)

6386 DIGITAL PERIOD METER. Inokuchi, Seiji (Osaka Univ.); Kobayashi, Takeshi; Sakurai, Yoshifumi; Furet, Jacques. J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 558-62(Oct 1971).

A new type of digital reactor period meter utilizing integrated circuits is described. The period is calculated from the number of counts N_2 during t_2 at $t = \tau$, where t_2 is equal to t_1 which is the interval required for $N_1 = 10^4$ at $t = 0$. Its output is the digital inverse period signal. The statistical error is delimited by fixing the number of counts instead of the counting interval. The absolute error is about 0.015 sec^{-1} in the case of a delay time of $\tau = 1$ sec. For $\tau \geqq 2$ sec, it becomes smaller than 0.008 sec^{-1}. The delay time τ is set to a value chosen among 1, 2, 4, 8, 16 and 32 sec, depending upon the count rate. The period meter contains about 250 integrated circuits, of which approximately 80 circuits are used for display and auxiliary functions not directly related to the primary purpose of period calculation. (auth)

6387 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hyde, John Edgar (to Atomic Power Constructions Ltd.). British Patent 1,250,316. 20 Oct 1971. Filed 30 Aug 1968.

Reference is made to control rod mechanisms for high temperature reactors. The mechanism described comprises a guide for the control rod, a latch unit releasably connected to the control rod, a hoist for raising and lowering the latch unit, and means for releasably connecting the guide to the latch unit. Operating mechanisms are described in detail. (UK)

6388 IMPROVEMENTS RELATING TO NUCLEAR REACTOR CONTROL ELEMENT OPERATING MECHANISMS. Baddley, Albert Harold; Laycock, William (to United Kingdom Atomic Energy Authority). British Patent 1,251,338. 27 Oct 1971. Filed 28 Feb 1968.

A control element operating mechanism is described which consists of two portions, one incorporating a lift-lower mechanism and an electromagnet for supporting the other portion which incorporates an armature for engagement with the magnet and a releasable mechanical coupling for engaging with a control element together with a further releasable mechanical coupling arranged so that the armature and magnet can be locked together. The present specification describes an improvement to this arrangement. The first mechanical coupling is located at one end of an extension member, the other end of which carries the armature with means for releasably coupling the armature to the magnet by effecting angular movement of the extension member. This movement serves also for uncoupling the extension member from the control element and without the necessity for imparting angular movement to the magnet. Reverse angular movement of the extension member first couples it to the control element and then mechanically uncouples the armature from the magnet. Various mechanisms for imparting augular movement remotely to the extension member are described. (UK)

6389 NUCLEAR FUEL PINS. Butterfield, Colin Edgar; Butterfield, Roy Stuart (to United Kingdom Atomic Energy Authority). British Patent 1,251,361. 27 Oct 1971. Filed 29 May 1968.

Reference is made to fuel pins consisting of a stack of fuel pellets in a sheath having heat transfer fins formed by machining circumferential grooves. During reactor operation the sheath expands axially more than the pellets, leaving part of the sheath unbacked by the stack. To avoid collapse of the sheath the unsupported part of the sheath has been deformed into antislumping grooves in or between the pellets engaging the stack at intervals. Such deformities have several stated disadvantages. In the design described the fuel pin comprises a stack of fuel pellets interposed between insulation pellets of non-fissile material, and enclosed in a sealed sheath having peripheral grooves machined in its surface to form heat transfer fins. The grooves are substantially co-extensive with the stack of pellets when the fuel pin is at room temperature, while at normal operating temperature voidage within the sheath caused by differential thermal expansion of the fuel and sheath is bounded solely by the ungrooved end portions of the sheath. (UK)

6390 CONTROL ROD DRIVE MECHANISM. Baker, Silveus Monroe (to Royal Industries, Inc.). British Patent 1,251,310. 27 Oct 1971. Priority date 16 Jun 1969, United States.

REACTOR CONTROL ELEMENTS—drives for rod type, description of motor stator with linear moving rotor (D.L.C.)

6391 CONTROL ROD DRIVE MECHANISM. Baker, Silveus Monroe; Moore, Wesley Dean (to Royal Industries, Inc.). British Patent 1,251,174. 27 Oct 1971. Priority date 9 Jul 1969, United States.

REACTOR CONTROL ELEMENTS—drives for rod type, description of motor stator with linear moving rotor (D.L.C.)

6392 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,248,966. 6 Oct 1971. Priority date 30 Nov 1967, United States.

REACTOR CONTROL ELEMENTS—drives for vertical rod type, description of gravity inserting and hydraulic positioning (D. L.C.)

6393 CLAD NUCLEAR FUEL BODY FACILITATING FUEL LEAK DETECTION IN A NUCLEAR REACTOR. Grossman, Leonard Nathan; Larson, Charles Louis; Rubin, Bernard Friedman (to General Electric Co.). British Patent 1,248,489. 6 Oct 1971. Priority date 15 May 1968, United States.

NEON ISOTOPES Ne-20—use for leak detection in helium filled metal clad rod type fuel elements

NEON ISOTOPES Ne-22—use for leak detection in helium filled metal clad rod type fuel elements

REACTOR FUEL ELEMENTS—leak detection system for metal clad rod type, description of neon-20 and neon-22 labeled helium filler gas (D.L.C.)

6394 NUCLEAR REACTOR CORE. Crowther, Russell Lee (to General Electric Co.). British Patent 1,248,483. 6 Oct 1971. Priority date 2 May 1968, United States.

REACTORS—core for, description of graduated enrichment dual zone plutonium fueled (D.L.C.)

6395 REACTOR-NOISE MONITORING FOR MALFUNCTIONS. Thie, Joseph A. Reactor Technol.; 14: No. 4, 354-65 (Winter 1971-1972).

Utilization of randomly fluctuating signals from reactor instrumentation for extracting useful information is reviewed. Emphasis is placed on ability to detect abnormalities. Signal sources treated are neutron flux, temperature, vibration, sound, strain, pressure flow, and gamma flux. Methods of analysis are discussed within the current state of the art. 49 references. (auth)

6396 FISSION-GAS EFFECTS IN REACTOR FUELS. PART II. ENGINEERING APPLICATIONS. Carroll, R. M. Nucl. Safety; 12: No. 6, 562-8(Nov-Dec 1971).

This review covers the papers published from 1968 to 1970 dealing with the engineering effects of fission gas in reactor fuels. The 73 publications cited and briefly summarized deal primarily with fuel-swelling models, high-temperature effects, new experimental techniques, and engineering for fission-gas release. (auth)

6397 TEMPERATURE MEASUREMENT IN NUCLEAR REACTORS BY NOISE THERMOMETRY. Brixy, H. G. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 97: No. 1, 75-80(1971).

The Nyquist theorem is used to determine absolute temperatures. The noise voltages of two resistors, one at the unknown temperature, the other at room temperature, are compared. The ratio of the resistances, when the noise voltages from the two resistors are equal, determines the ratio of their absolute temperatures. In the laboratory, several temperatures were measured in the range from 300 K to 1100 K with an accuracy better than 0.2 percent. Also in the reactor FRJ-2, temperatures were measured with similar precision in a radiation field of 6×10^{13} nv and 3×10^{5} R/h. The noise thermometer is independent of the material from which it is made and its previous thermal and mechanical treatment. It is also independent of the environment like nuclear radiation, and therefore especially suitable for temperature measurement in nuclear reactors. (auth)

6398 ELECTROMAGNETIC SYSTEM FOR THE RECTILINEAR TRANSLATION OF ELEMENTS OF NUCLEAR REACTORS. Kumpf, H. (to Siemens AG). German Patent 1,514,614. 11 Sep 1969. Filed 5 Nov 1965. (In German).

An electromagnetic rectilinear translation system for elements, particularly control or shut-down rods of a reactor, is described. It consists of magnet poles arranged at regular intervals on the exterior of the tube, exciting coils triggered separately, and a rotor connected to the poles placed at the interior of the tube. The distribution of the magnet poles arranged between the exciter coil is arranged so that several pole shoes are placed in proximity with two exciting coils. (tr-auth)

6399 METHOD FOR THE DETECTION OF CAN DAMAGE IN FUEL ELEMENTS. Jacobi, Siegfried (to Gesellschaft fuer Kernforschung mbH). German Patent 1,489,895. 23 Oct 1969. Filed 15 Jan 1965. (In German).

A method for the detection of can damage of reactor fuel elements is described. The beta activity of the coolant is measured directly in the reactor radiation field immediately after its passage over the fuel cans. An electrode permeable to beta radiation is used in the method. (tr-auth)

6400 NEUTRON FLUX RECORDER UTILIZING A CONTINUOUS WEB OF TRACK-REGISTRATION MATERIAL. Alter, Henry Ward (to General Electric Co.). U. S. Patent 3,612,873. 12 Oct 1971. Filed 23 Dec 1968.

A neutron flux recorder is disclosed which is capable of continuously monitoring the neutron flux level of a nuclear reactor over an extended period of time. This recorder utilizes a continuous web of track-registration material which is slowly passed adjacent a slit containing a source material which emits charged particles such as fission fragments or alpha particles when irradiated with neutrons. The rate of charged particle emission by the source material is directly proportional to the neutron flux. The charged particles which strike the track-registration material form damage tracks therein. These tracks may be etched by treatment with a suitable etchant. The resulting etched tracks are visible and may be counted or otherwise measured. This produces a permanent record of the neutron flux level adjacent the recorder. These recorders can be made tamperproof and are capable of recording flux levels for periods on the order of a year. (auth)

GENERAL

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From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

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6433 (UCRL-51013(Pt.1)(Rev.1)) COMPILATION OF PUBLISHED INFORMATION ON ELEMENTAL CONCENTRATIONS IN HUMAN ORGANS IN BOTH NORMAL AND DISEASED STATES. 1. RAW DATA ORDERED BY ATOMIC NUMBER, SUBORDERED BY ORGAN AND SUBORGAN, LISTING METHOD OF ANALYSIS, GEOGRAPHICAL SOURCE, AGE, SEX, NUMBER OF INDIVIDUALS. Anspaugh, L. R.; Robison, W. L.; Martin, W. H.; Lowe, O. A. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Aug 1971. Contract W-7405-eng-48. 161p. Dep. NTIS.

The report issued originally under this title was the first of a series of compilations of the published data on the elemental content of human tissues in both healthy persons and those afflicted with one or more diseases. The present revision is issued to correct errors of omission and various coding errors in the compilation of raw data. The objective of the series of reports is to organize the very large volume of available data in such a way that it will be useful for a variety of purposes. This initial report contains the elemental concentrations and other raw data (coded by number) for each of the papers entered into the system. Also included is the key defining the code numbers and the reference list from which the data were obtained. The data are ordered by atomic number, subordered by organ and where appropriate by suborgan. Other information listed includes method of analysis, geographical source, age, sex, health state, concentration unit, and number of individuals. This report is primarily a listing of the raw data. Subsequent reports in the series are data summaries giving the mean elemental concentration in each organ from all papers coded in the system. One report is ordered by atomic number, subordered by organ, suborgan, and by general health state. Another is ordered by organ, subordered by atomic number, and by general health state, while yet another is ordered by specific disease and subordered by atomic number, by organ, and by suborgan. (auth)

6434 (UCRL-51013(Pt.2)) COMPILATION OF PUBLISHED INFORMATION ON ELEMENTAL CONCENTRATIONS IN HUMAN ORGANS IN BOTH NORMAL AND DISEASED STATES. 2. DATA SUMMARY ORDERED BY ATOMIC NUMBER, SUBORDERED BY ORGAN, SUBORGAN, AND GENERAL HEALTH STATE. Anspaugh, L. R.; Robinson, W. L.; Martin, W. H.; Lowe, O. A. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Aug 1971. Contract W-7405-eng-48. 108p. Dep. NTIS.

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